



D3.7. QuantiFarm Toolkit – second version

quantifarm.eu



D3.7 QuantiFarm Toolkit – second version

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Abstract:	<p>This deliverable describes the technical specifications and the implementations of the QuantiFarm Toolkit. The Toolkit is available for use as a web-based dashboard (https://quantifarmtoolkit.eu/) and offers controlled access to various functionalities elaborating on the assessment of Digital Agricultural Technology Solutions (DATSs). Each user type (farmer, advisor, policy maker) has different type of access to the dashboard with dedicated visualisation tools, and an option to create a user profile associated with parameters such as crop types, DATS of interest, geophysical region, etc. which can be used to influence the outcomes provided by the various tools. The toolkit currently provides access to 5 tools entitled: “DATSs Recommendation-tool”, “DATSs Cost benefit calculator”, “Farming activities benchmarking tool”, “DATSs advanced decision support”, and the “Policy monitoring”. The toolkit also visualises assessment outcomes for the DATSs that are evaluated in the context of QuantiFarm Test Cases. Finally, this deliverable should be considered as a complementary document along with the QuantiFarm Toolkit source-code available in code repository: https://gitlab.com/QuantiFarm/uiproto. The first version of the Quantifarm toolkit was released on 12/2023 (M18). This deliverable provides descriptions of the updated functionalities available through the second release of the toolkit available on 4/2025.</p>



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Document Revision History			
Date	Version	Author/Contributor/Reviewer	Summary of main changes
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01/02/2025	0.2	Odysseas Sekkas, Ivaylo Dobrev	Technical description of the web platform updates
31/03/2025	0.3	George Charvalis, Jack Verhoosel, George Papadopoulos, Thanasis Manos, Odysseas Sekkas	Descriptions of the updates on individual tools.
8/4/2025	0.5	Dionysios Solomos, Alkis Kyriakou	Internal review
11/04/2025	1.0	Nikos Kalatzis, Odysseas Sekkas, Georgios Charvalis	Final version addressing all comments from peer-reviewers

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4	NEUROPUBLIC AE PLIROFORIKIS & EPIKOINONION	NP	GR
5	CONSULAI, CONSULTORIA AGROINDUSTRIAL LDA	CONSULAI	PT
6	CONFEDERAZIONE GENERALE DELL AGRICOLTURA ITALIANA	CONFAGRICOLTURA	IT
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8	PETERSON PROJECTS BV	PETERSON	NL
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11	OKYS LTD	OKYS	BG
12	COMITE DES ORGANISATIONS PROFESSIONNELLES AGRICOLE DE L UNION EUROPEENNE COPA ASSOCIATION DE FAIT	COPACOGECA	BE
13	COMITE EUROPEEN DES GROUPEMENTS DE CONSTRUCTEURS DU MACHINISME AGRICOLE	CEMA	BE
14	TEAGASC - AGRICULTURE AND FOOD DEVELOPMENT AUTHORITY	TEAGASC	IE
15	INSTITUTO TECNOLOGICO AGRARIO DE CASTILLA Y LEON	ITACyL	ES
16	HORTA SRL	HORTA	IT
17	KATHOLIEKE UNIVERSITEIT LEUVEN	KUL	BE
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21	ASOCIATIA NATIONALA A INDUSTRIILORDE MORARIT SI PANIFICATIE DIN ROMANIA	ANAMOB	RO
22	UAB ART21	ART21	LT
23	AGROSMART SIA	AgroSmart	LV
24	BENCO BALTIC DOO ZA SAVJETOVANJE IUSLUGE	BENCO	HR
25	FARM FRITES POLAND DWA SPOLKA Z OGRANICZONA ODPOWIEDZIALNOSCIA	FFP2	PL
26	AGROMAIS PLUS COMERCIO E SERVICOSAGRICOLAS S.A.	AGROMAIS	PT
27	KMETIJSKO GOZDARSKA ZBORNICA SLOVENIJE KMETIJSKO GOZDARSKI ZAVOD MURSKA SOBOT	KGZS	SI
28	TERRA LITTERA DOO	Terra	RS
29	ANYSOLUTION SL	AnySol	ES
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List of Abbreviations and Acronyms	
API	Application Programming Interface
AKIS	Agriculture Knowledge and Innovation Systems
CAP	Common Agricultural Policy
DATS	Digital Agriculture Technology Solution
DB	Database
DIH	Digital Innovation Hub
DMP	Data Management Plan
EDIH	European Digital Innovation Hubs
EIP-AGRI	European Innovation Partnership for Agricultural productivity and Sustainability
EC	European Commission
EO	Earth Observation
EU	European Union
EUPL	European Union Public Licence
FMIS	Farm Management Information System
GDPR	General Data Protection Regulation
ICT	Information and Communications Technology
IPR	Intellectual Property Rights
JRC	Joint Research Centre
QA	Quality Assurance
QC	Quality Control
RDF	Resource Description Framework
TC	Test Case
USGS	United States Geological Survey
VRA	Variable Rate Application
WP	Work Package



1. Introduction

1.1. Project Summary

The QuantiFarm project focuses on supporting the further development of Digital Agriculture Technology Solutions (DATS) in order to improve the sustainability (economic, environmental and social) and competitiveness of the EU’s agricultural sector. To this end, QuantiFarm develops a comprehensive Assessment Framework for independent qualitative and quantitative assessments of the costs and benefits of digital agriculture technologies. The project will support the uptake of digital technologies by providing innovative tools and services and will provide practical recommendations of relevance and practical utility to farmers, advisors, and policy makers across Europe. QuantiFarm is building its assessment and recommendation tools using data derived from 30 Test Cases (TCs) which span over 20 countries in 10 Biogeographical regions across Europe, thereby capturing multiple social, environmental, and economic parameters. More than 100 farms of different types, sizes, ownership and operating conditions, have committed to participate in the project, both directly and through cooperatives and large umbrella organisations. In addition, the QuantiFarm Digital Innovation Academy will provide capacity building capabilities for advisors and other Agriculture Knowledge and Innovation Systems (AKIS) actors, by providing data on the various types of digital technologies available, their costs, benefits and impact on sustainability. QuantiFarm involves 32 partners, representing a variety of stakeholders, including 8 scientific organisations and 12 farmer representatives and consultants.

1.2. Document Scope

This deliverable describes the technical specifications and the implementations of the QuantiFarm Toolkit. The Toolkit is available for use as a web-based dashboard (<https://quantifarmtoolkit.eu/>) and offers controlled access to various functionalities with regards to DATS assessment. Each user type (farmer, advisor, policy maker) has different type of access to the dashboard with dedicated visualisation tools, and an opportunity to provide user profile properties (e.g. crop types of interest, DATS of interest, geophysical region) which can be used to influence the rankings of the advisory services. The toolkit currently provides access to 5 tools entitled: “DATS Recommendation-tool”, “DATS Cost benefit calculator”, “Farming activities benchmarking tool”, “DATS advanced decision support tool”, and the “Policy monitoring”. The toolkit also provides assessment outcomes for selected DATS that are evaluated in the context of QuantiFarm test cases. This deliverable is mainly a report that provides essential descriptions on the use of the actual Toolkit. The design specifications, utilisation scenarios and installation directions for the individual tools are available in “D3.3. Tools for DATSs Assessment and Policy Monitoring – initial version” and “D3.4. Tools for DATSs Assessment and Policy Monitoring – second version”. More technical details on the utilisation of the tools, including the source code and detailed technical specifications are available in QuantiFarm code repository: <https://gitlab.com/QuantiFarm>.

This is the second release of the “QuantiFarm Toolkit” where its core structure and overall user-experience to be offered have been finalised. The functionalities offered by the different tools are updated to be more sophisticated as the volumes of data handled by the QuantiFarm (back-end) platform are increasing. A major push took place once the assessment of the various DATS in the context of QuantiFarm Test Cases was finalized, and the resulting outcomes have already been made available for reuse by the QuantiFarm tools. All future updates to be realised will be bundled and documented in the final release on M45 of the QuantiFarm project.

The updates implemented since its initial release on M18 are also based on the feedback from each actual usage from TC actors but also from external stakeholders. Between M19 and M33, several co-creation and feedback sessions were organized as part of QuantiFarm’s multi-actor and iterative approach to continuously refine the toolkit. These sessions included:



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- 5th Plenary Meeting (26 June 2024) – Interactive session with QuantiFarm partners
- 1st EU-wide training workshop with TCs farm advisors (28 June 2024)
- Workshop “QuantiFarm toolkit: An all-in-one service for digital agriculture technology solutions” at Synergy Days 2024 (14 October)
- Feedback to Policy Cluster Event: Digitalization for farmers and rural communities (5 November 2024)
- 2nd EU-wide training workshop – Joint Online Seminar with EUFRAS (28 November 2024 – 96 participants)
- 6th Plenary Meeting (05 December 2024) – Interactive session with QuantiFarm partners

Comparing with the initial release the most important updates of the toolkit are:

- 1) The availability of the Toolkit GUI in additional languages. This was considered as a key requirement towards the further utilisation of the Toolkit from farmers and advisors of EU countries.
- 2) The DATS Recommendation Tool is significantly improved having available for use more sophisticated recommendations engines but also in terms of user interface. More details are available in the updated section 3.1.
- 3) The “Benchmarking Tool” now supports the management and processing of additional data types included in the provided datasets allowing for enhanced aggregations and calculation of performance indicators. More details are available in the updated section 3.2.
- 4) The “Cost and Benefit calculator” integrates in its knowledge base outcomes derived from the assessment of DATSs in the context of the QuantiFarm Test Cases. Previously, it was only based on evidence based on the state-of-the-art review given that on M18 outcomes from TC were not yet available. More details are available in the updated section 3.3.
- 5) The “Policy Monitoring tool” integrates evidence, calculated indicators and supports projections for additional areas across EU based on the outcomes generated by 12 selected QuantiFarm test cases. More details are available in the updated section 3.5
- 6) The DATS assessment outcomes derived by the TCs datasets and the QuantiFarm assessment framework (WP2) are now presented in a more intuitive and user-friendly way. This was among our core objectives given that QuantiFarm project aims to support further adoption of DATS through the provision of ground-truth evidence of their assessed performance to Farmers and Advisors. More details are available in the updated section 2.2.3.



1.3. Document Structure

This report is structured as follows:

- **Chapter 1** provides a summary of the project, the document's scope and its overall structure.
- **Chapter 2** provides details on the implementation technologies of the QuantiFarm toolkit available as a web-based Dashboard.
- **Chapter 3** provides screenshots and directions of use for each tool in dedicated subsections.
- **Chapter 4** provides information about the newly introduced QuantiFarm FAQ section.
- **Chapter 5** includes conclusions and the next steps for toolkit refinement until the end of the project.



2. QuantiFarm Dashboard

1.1. Development Technologies

The QuantiFarm Toolkit is available for use through a web based and user-friendly Dashboard. The overall architecture follows an [API gateway pattern](#) which is a common architectural pattern in which an API gateway sits between the client and a collection of microservices. The API gateway acts as a single-entry point for clients to access the microservices, allowing clients to interact with the microservices as if they were a single service. The API gateway perform tasks such as authentication, rate limiting, and caching to improve the performance and security of the microservices. This pattern is often used in microservice-based architectures to help manage and route requests to the various microservices.

In the case of QuantiFarm Toolkit the microservices are the different tools that are specified in “D3.3. Tools for DATSs Assessment and Policy Monitoring – initial version”. The generic engines, tool services and user interface are together deployed on the QuantiFarm server located at the URL <https://quantifarmtoolkit.eu>. The code of the toolkit is available in a dedicated Gitlab code repository (<https://gitlab.com/QuantiFarm/uiproto>)

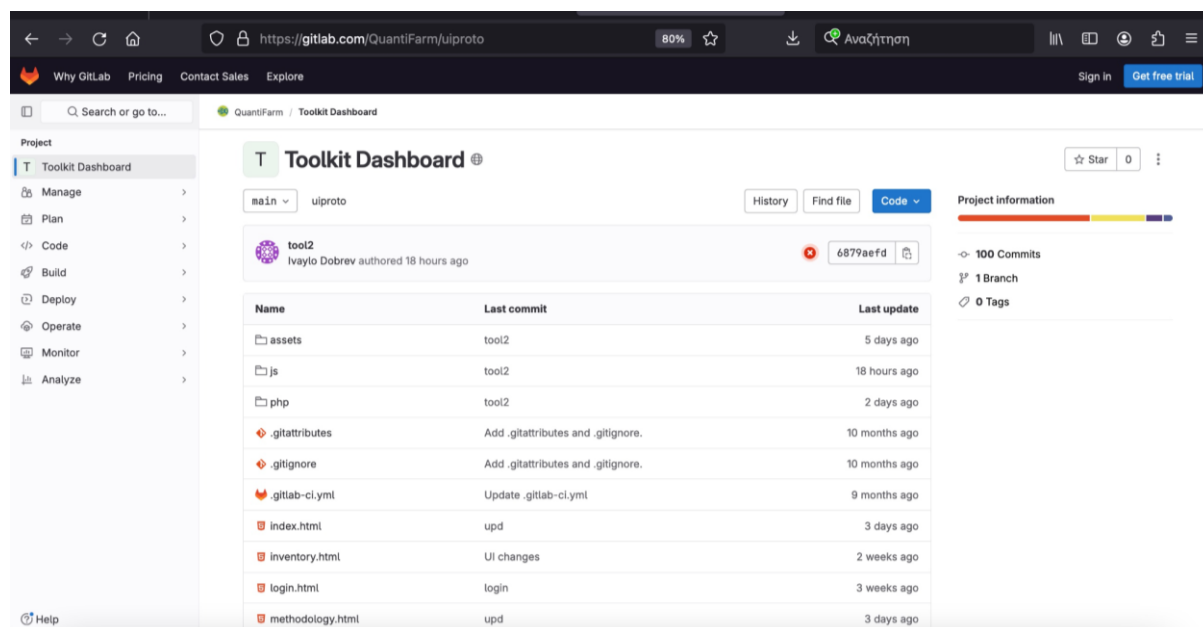


Figure 1. The code repository of the QuantiFarm Toolkit (<https://gitlab.com/QuantiFarm/uiproto>)

2.1.1 Server technology

QuantiFarm server is a [Virtual Private Server](#) (VPS) hosted in a [Tier 3+](#) datacenter, physically located in EU - Sofia, Bulgaria. VPS specifications: 6 vCPU, 12 GB RAM, 300 SSD. These specifications may be extended depending on the server workload. Operating system is [Ubuntu](#), the web server is [Apache HTTP Server](#) and the containerization engine is [Docker](#). It should be noted that all technologies (Ubuntu, Apache, Docker) are Open Source.



2.1.2 Development framework

The tools are developed as standalone applications deployed as Docker containers on the VPS. The Toolkit Dashboard is a web application developed with php, javascript and HTML5. The Dashboard communicates with the tools via a REST API.

2.1.3 Security mechanisms

Two independent and complementary security mechanisms are implemented. User registration and login is required for the tools that process sensitive data. Registration requires minimum user data - name, email and password. User data is stored in a database on the server. User's passwords are encrypted. Second security mechanism is based on the architecture of the Quantifarm Toolkit. All tools and Toolkit Dashboard are deployed on the same VPS. Tools backend APIs are invoked internally from the Toolkit Dashboard backend and are not accessible to the public. Connection to the website is secured by [SSL certificate](#). SSL certificates ensures the verification of the owner of a website and implements encryption on the web traffic with SSL/TLS, including the public key, the issuer of the certificate, and the associated subdomains.

1.2. Dashboard structure

This section presents an overview of the QuantiFarm web-based dashboard. It should be noted that the Dashboard is designed to maintain dynamic content that will be refined and improved accordingly when additional results and functionalities are available. The objective of presenting the following screenshots and descriptions is to document the current (updated) release of the toolkit. The most up-to-date version will always be available by visiting the actual Dashboard: <https://quantifarmtoolkit.eu/>

The Dashboard follows a [responsive design](#) and it is optimised for use from devices of different screen size.

In an effort to ensure maximum accessibility and outreach, the QuantiFarm dashboard (together with all associated pages, tools description and FAQs) is provided in **16 different languages**. This multilingual capability broadens the scope of dissemination, enabling farmers, advisors, and policymakers from diverse linguistic backgrounds to access and benefit from QuantiFarm's toolkit and the project promotes the collaboration between the European agricultural community.

Table 1 Language list

1	EN	English
2	EL	Greek
3	ES	Spanish
4	FI	Finnish
5	FR	French
6	IT	Italian
7	LT	Lithuanian
8	LV	Latvian
9	NL	Dutch
10	PL	Polish



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11	PT	Portuguese
12	RO	Romanian
13	SL	Slovenian
14	SR	Serbian
15	TR	Turkish
16	SV	Swedish

2.2.1 Home page

Home Toolkit Test cases FAQ Contacts

Welcome to
QuantiFarm Toolkit

QuantiFarm supports the further deployment of digital agriculture technology solutions as key enablers for enhancing the sustainability performance and competitiveness of the agricultural sector.

The QuantiFarm toolkit utilises descriptions of Digital Agricultural Technology Solutions (DATS) derived from the following sources:

- The Fairshare inventory which lists about 300 DATS that are used by QuantiFarm's Recommendation tool.
- A set of about 100 DATS that have been extracted based on the state-of-the-art literature review and are utilised by the Cost and Benefit Calculator.
- A set of DATS that are evaluated with the use of the QuantiFarm Assessment framework. See the results in the Test Cases section.

Start using the QuantiFarm tools:

- Farmer**
 - Recommendations Tool
 - Cost and Benefit Calculators
 - Benchmarking Tool
- Advisor**
 - Recommendations Tool
 - Cost and Benefit Calculators
 - Benchmarking Tool
 - Advanced Decision Support Tool
- Policy Maker**
 - Policy Monitoring Tool

Are you DATS provider?

We are excited to announce that our online directory for Digital Agriculture Technology Solutions now features a submission form for tech providers. If you offer innovative technology solutions for agriculture, we invite you to share your product details with us for inclusion in our comprehensive catalogue and featured tools.

By joining our directory of DATS, you will connect with a broad audience of farmers and agricultural advisors seeking cutting-edge digital tools to improve their operations. Don't miss this opportunity to showcase your offerings!

Simply fill out the form with the necessary information about your product, and we'll review your submission for inclusion.

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Figure 2. The landing page of QuantiFarm Toolkit

The QuantiFarm Dashboard maintains a horizontal menu bar with the following menu items: “**Home**”, “**Toolkit**”, “**Test Cases**”, “**FAQ**”, “**Contact**” (see Figure 2).

The landing page provides a welcome note and generic information on how to use the various services. It also offers details about the Digital Agricultural Technology Solutions (DATS), including the current

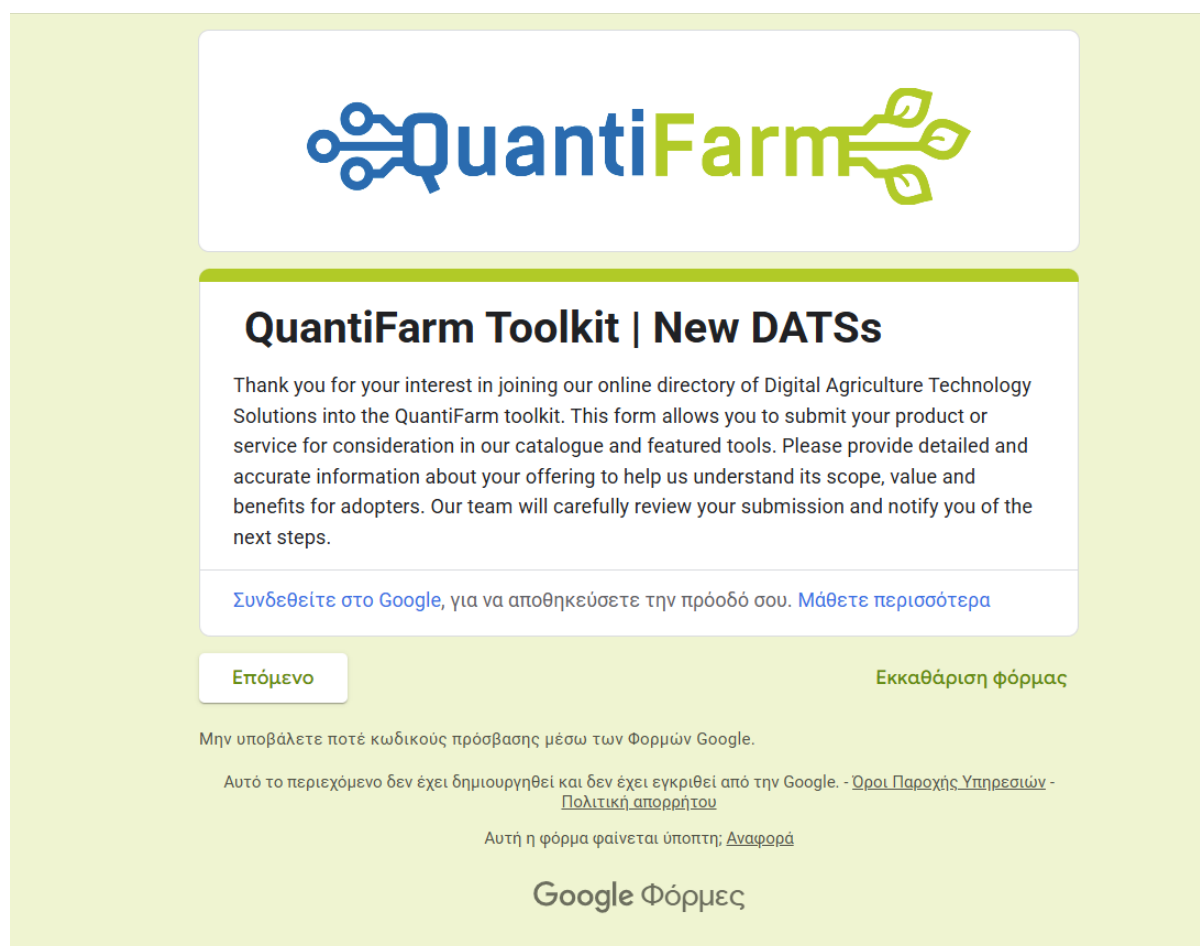


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count of 535 DATS in our online directory. All of them are used in the recommendation tool, 122 are used in the cost-benefit calculator tool (Livestock:50 + Arable: 72), while 8 are utilized in the policy monitoring tool. This database, which is continuously expanding, consolidates information from multiple sources to ensure an up-to-date coverage of available solutions.

2.2.2 Submission form

The home page also provides an overview of the online directory of DATSs. In addition to existing solutions, it invites technology providers to submit their offerings for inclusion. The submission details specify the product information required—such as solution name, target users, cost structure, and core functionalities—to ensure each entry is accurately represented. The submitted offerings are reviewed by the WP3 technical team to ensure the accuracy and credibility of the provided product details, as well as DATS’s compatibility with inventory requirements. A direct link to the submission form (<https://forms.gle/dL6N7Lnpmctoz94L8>) is given, making it easy for providers to add new DATSs. Through this process, the directory remains dynamic and continuously expands to reflect the latest developments in digital agriculture technologies.



The image shows a screenshot of a web form titled "QuantiFarm Toolkit | New DATSs". At the top, there is a logo for "QuantiFarm" which combines a circuit-like icon with a leafy branch. Below the logo, the title "QuantiFarm Toolkit | New DATSs" is displayed in bold. The main text of the form reads: "Thank you for your interest in joining our online directory of Digital Agriculture Technology Solutions into the QuantiFarm toolkit. This form allows you to submit your product or service for consideration in our catalogue and featured tools. Please provide detailed and accurate information about your offering to help us understand its scope, value and benefits for adopters. Our team will carefully review your submission and notify you of the next steps." Below this text is a link: "Συνδεθείτε στο Google, για να αποθηκεύσετε την πρόσοδό σου. Μάθετε περισσότερα". There are two buttons: "Επόμενο" (Next) on the left and "Εκκαθάριση φόρμας" (Clear form) on the right. At the bottom, there is a disclaimer in Greek: "Μην υποβάλετε ποτέ κωδικούς πρόσβασης μέσω των Φορμών Google. Αυτό το περιεχόμενο δεν έχει δημιουργηθεί και δεν έχει εγκριθεί από την Google. - Όροι Παροχής Υπηρεσιών - Πολιτική απορρήτου" and "Αυτή η φόρμα φαίνεται ύποπτη; Αναφορά". The footer of the form says "Google Φόρμες".

Figure 3. The submission form of the new DATSs



A. DATS IDENTIFICATION

Name of technological solution (DATS) *

Your answer _____

Agricultural practice addressed by the DATS *

Crop farming

Livestock farming

DATS category *

Farm Management Information Systems (FMIS) and applications (incl. DSSs and QMSs)

Guidance / Controlled Traffic Farming (CTF) technologies

Reacting or Variable Rate Technologies (VRT)

Recording or Mapping technologies (inc. monitoring systems, real-time location systems (RTLS))

Figure 4. Details for submission form of the new DATSs



2.2.3 QuantiFarm toolkit

By selecting the “Toolkit” menu item, the user can view all available tools—each accompanied by a brief description—and can select one of them for use. Updates have been made to the tools’ descriptions to reflect the new features that have been implemented since the last Deliverable 3.6.

The screenshot displays the QuantiFarm Toolkit page. At the top, there is a navigation bar with links for Home, Toolkit, Test cases, FAQ, and Contacts. Below the navigation bar is a row of flags representing various countries. The main content area features five tool cards arranged in a grid. Each card includes a title, a brief description, and a target audience. The tools are: Recommendations Tool (for Farmers and Advisors), Cost and Benefit Calculators (for Farmers and Advisors), Benchmarking Tool (for Farmers and Advisors), Advanced Decision Support Tool (for Advisors), and Policy Monitoring Tool (for Policy Makers). At the bottom of the page, there is a footer with the European Union logo, funding information, and copyright details.

Figure 5. The “QuantiFarm” Toolkit page

For each tool a “Download” link redirects the user to the respective code development repository pages:

- <https://gitlab.com/QuantiFarm/benchmarking-tool>
- <https://gitlab.com/QuantiFarm/recommendation-tool>
- <https://gitlab.com/QuantiFarm/cost-benefit-calculator>
- <https://gitlab.com/QuantiFarm/policymonitoring-tool>
- <https://gitlab.com/QuantiFarm/advanced-decision-support-for-dat-selection-tool>

At the code repository’s page directions for download and installing the backend services are provided.



D3.7 QuantiFarm Toolkit – second version

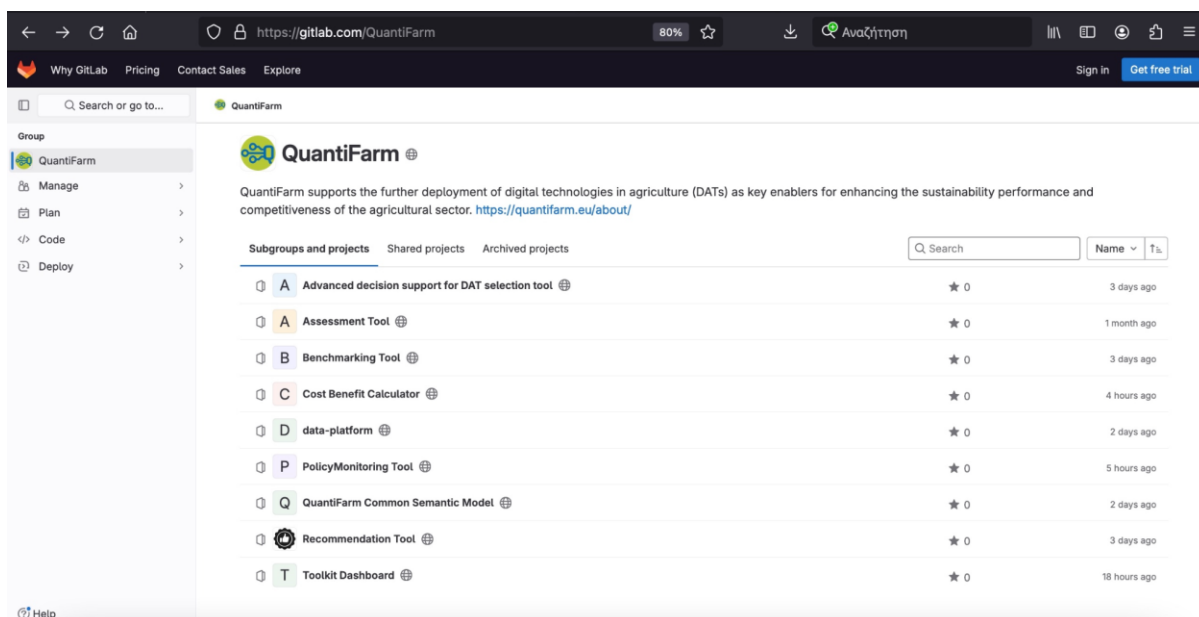


Figure 6 The QuantiFarm Tools available for download and reuse.

A detailed description on how to use each tool is available in Section 3.

2.2.4 QuantiFarm Test Cases page

The QuantiFarm dashboard also offers detailed descriptions and DATS assessment outcomes generated in TCs through the DATS application and evaluation process. The user can select from the main menu the respective option entitled “Test cases” and view the respective list of test cases in a table view. (Figure 7)

The screenshot shows the 'Test cases' page in the QuantiFarm Toolkit. The page displays a table of assessment results for 30 test cases. The table has the following columns: No, Sector, Crop / Animal, Digital Solution, Country, Partner, and Results. The table is filtered to show 10 test cases.

No	Sector	Crop / Animal	Digital Solution	Country	Partner	Results
1	Arable	Potatoes	SF DSS/ App	Greece	NP	
2	Arable	Corn	Precision Irrigation	Portugal	Agromais	
3	Arable	Barley, wheat	SF DSS/ Agro-environmental Monitoring	Spain	ITAcYL	
4	Arable	Cotton	VRA add-on for old tractors	Greece	Augmenta	
5	Arable	Wheat	SF DSS/ App	Turkiye	HORTA	
6	Arable	Wheat, onion, potato	Machinery with VRA, data analytics	Netherlands	Delphy	
7	Arable	Potatoes	SF DSS/ App	Poland	FFP2	
8	Arable	Wheat	Silo management	Latvia	AgroSmart	
9	Arable	Barley, corn, wheat	FMIS/ Financial Modelling	Slovenia	KGZS	
10	Arable	Wheat	FMIS/ app	Romania	ANAMOB	

Figure 7. The full list of QuantiFarm's Test Cases

To make this process more intuitive the Test Cases outcomes are also available with the use of a map with pins indicating the country where the test cases are located and implemented.



D3.7 QuantiFarm Toolkit – second version

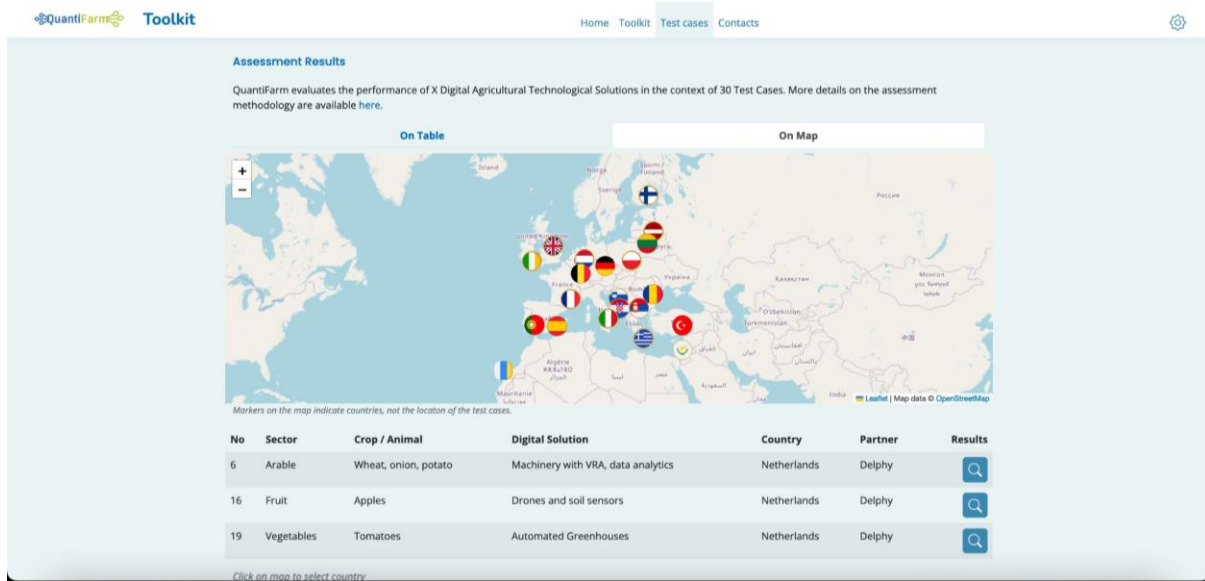


Figure 8. The QuantiFarm's Test Cases presented through a map.

The user can select to view the detailed outcomes from a specific test case (Figure 9 and Figure 10).

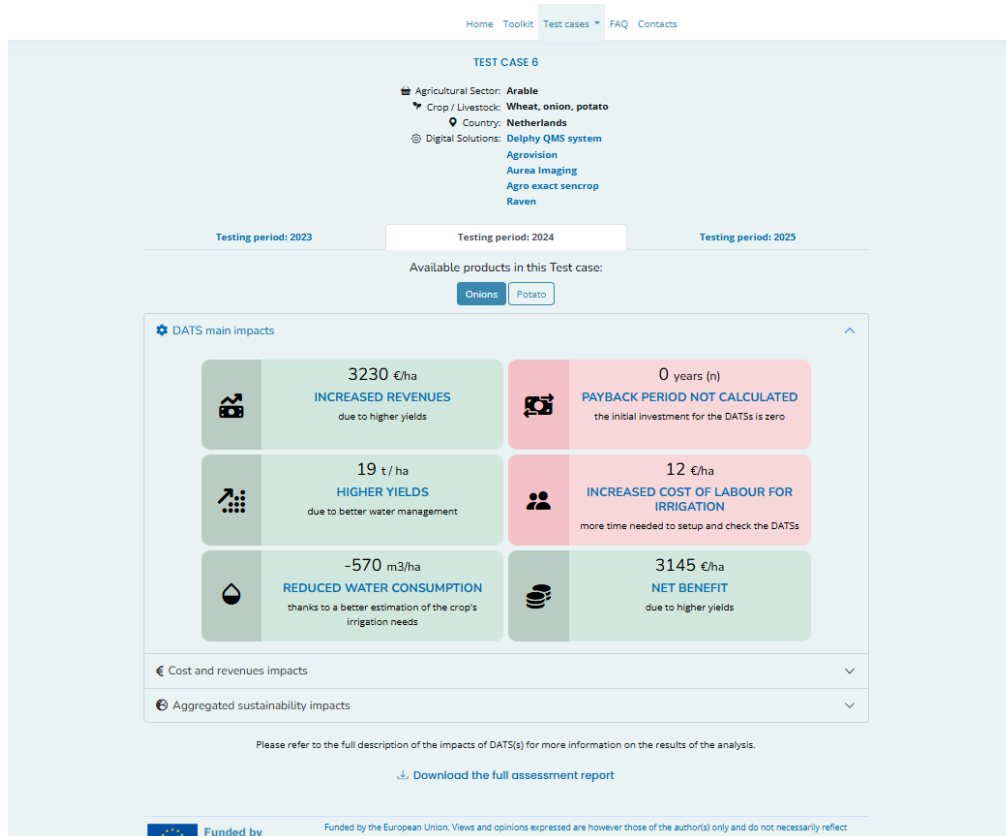


Figure 9. Example of DATS assessment outcomes for Test Case 6.



D3.7 QuantiFarm Toolkit – second version

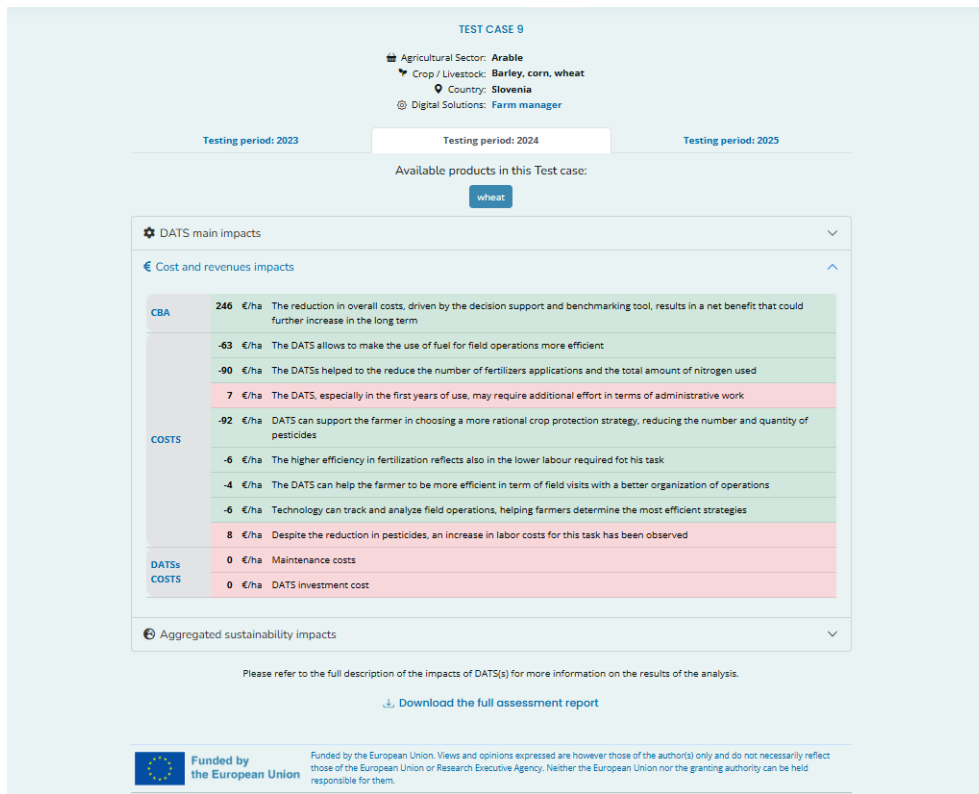


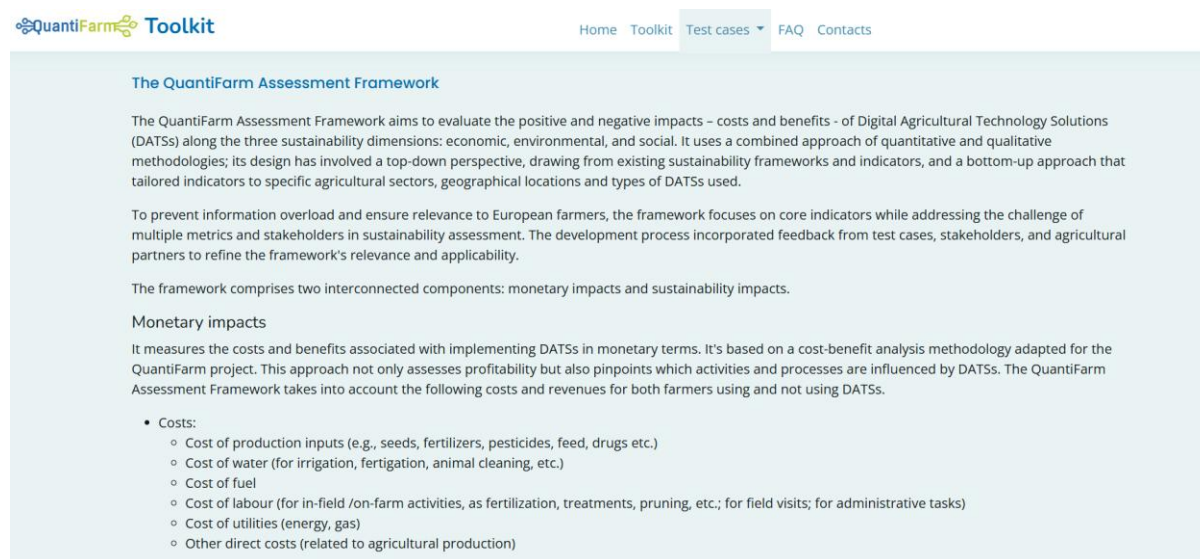
Figure 10. Example of DATS assessment outcomes for Test Case 9.

To promote a clear and accessible view of each DATS’s performance, the QuantiFarm toolkit presents its findings with a user-friendly approach, making it easy even for individuals less familiar with web dashboards or graph interpretation. Specifically, indicators where the ADS performed well are highlighted in **green**, while areas showing no significant benefit are marked in **red**. This intuitive color-coded system enables all users to quickly understand and act on key performance insights as seen also in the example presented in Figure 9 and Figure 10.



D3.7 QuantiFarm Toolkit – second version

For more details on the underlying Assessment Framework and methodology, you can visit the “Methodology” page at <https://quantifarmtoolkit.eu/methodology.html> in the “Test Cases” menu item which offers additional insights into how the results were derived (Figure 11).



The QuantiFarm Assessment Framework

The QuantiFarm Assessment Framework aims to evaluate the positive and negative impacts – costs and benefits - of Digital Agricultural Technology Solutions (DATS) along the three sustainability dimensions: economic, environmental, and social. It uses a combined approach of quantitative and qualitative methodologies; its design has involved a top-down perspective, drawing from existing sustainability frameworks and indicators, and a bottom-up approach that tailored indicators to specific agricultural sectors, geographical locations and types of DATSs used.

To prevent information overload and ensure relevance to European farmers, the framework focuses on core indicators while addressing the challenge of multiple metrics and stakeholders in sustainability assessment. The development process incorporated feedback from test cases, stakeholders, and agricultural partners to refine the framework's relevance and applicability.

The framework comprises two interconnected components: monetary impacts and sustainability impacts.

Monetary impacts

It measures the costs and benefits associated with implementing DATSs in monetary terms. It's based on a cost-benefit analysis methodology adapted for the QuantiFarm project. This approach not only assesses profitability but also pinpoints which activities and processes are influenced by DATSs. The QuantiFarm Assessment Framework takes into account the following costs and revenues for both farmers using and not using DATSs.

- Costs:
 - Cost of production inputs (e.g., seeds, fertilizers, pesticides, feed, drugs etc.)
 - Cost of water (for irrigation, fertigation, animal cleaning, etc.)
 - Cost of fuel
 - Cost of labour (for in-field /on-farm activities, as fertilization, treatments, pruning, etc.; for field visits; for administrative tasks)
 - Cost of utilities (energy, gas)
 - Other direct costs (related to agricultural production)

Figure 11. A short overview of QuantiFarm's DATS assessment methodology.

This page presents the QuantiFarm Assessment Framework methodology, which evaluates both the costs and benefits of registered DATSs across economic, environmental, and social dimensions. Developed through a blend of top-down (drawing from existing sustainability frameworks) and bottom-up (adapting to specific sectors and regions) approaches, the framework focuses on core indicators to avoid information overload and maintain relevance for European farmers.

The methodology is split into two main components:

- **Monetary impacts** – Based on a cost-benefit analysis that accounts for production inputs, water and fuel usage, labor, and revenue changes stemming from DATS adoption. It also outlines investment costs (hardware, software, management) and ongoing expenses (IT services, annual subscriptions).
- **Sustainability impacts** – Uses a Triple Bottom Line approach to assess economic, environmental, and social indicators (e.g., efficiency, nutrient application, greenhouse gas emissions, work-life balance, gender equality).

Refinement of this framework involved feedback from test cases and stakeholders as mentioned in the section 1.2, ensuring that it accurately captures how digital technologies influence farm operations.



3. QuantiFarm Toolkit

This section presents a high-level description of each QuantiFarm tool’s functionality as well as directions of use.

3.1 Recommendation tool

3.1.1 Description

The second Release Version 2.0 of the Recommendation Tool is an interactive recommender tool that allows farmers and farm advisors to (1) search through a large set of available Digital Agricultural Technology Solutions (DATSs) using filters for available DATS parameters, (2) ask for a recommendation for one or more DATSs that match specific characteristics of the farm and farmer, and (3) do a text search in the title, description and keywords of DATSs, which is an additional functionality compared to Version 1.0 of the Recommendation Tool. This search functionality is in place to further support users that actively search for DATSs or their aspects. In Version 2.0, DATSs from multiple sources are ingested by the Recommendation Tool, coming from the Fairshare collection, a DATS investigation for the cost-benefit tool as well as the collection of DATS used in the test cases, which are all shown to the user in a uniform fashion. For each selected DATS, a list of their aspects is presented to show more details about the DATS. This includes the cost structure, agricultural sector, benefits and digital form. The Recommendation Tool aims to be easy to use and the farmer shouldn’t need special training or extended help from the advisor. Technically the tool is based on a knowledge-based recommender system (building on existing systems and expertise) using a combination of reasoning and constraint satisfaction to provide a ranked list of the most suitable DATSs for any given farm/crop/biogeographical region combination.

3.1.2 Recommendation tool dashboard/GUI

When a farmer or farm advisor is interested in which DATSs are available that might be of use to reach specific goals with the farm, they can use the QuantiFarm toolkit as a supportive means. This can be reached via the “Toolkit” page available at: <https://quantifarmtoolkit.eu>. The “Recommendation Tool” can either be selected directly or can be reached via the “Farmer role” or “Advisor role” button, after which the user will see a welcome page with a description of the tool. The “Recommendation” tab can be used to do a “Recommend DATSs” based on a combination of

- A natural language text in the “Search text” field,
- The selected filters for DATS parameters in the left-hand column,
- Entered farmer profile information in the top-part of the page, and
- A selected recommendation algorithm also in the top part of the page.

Search text

A natural language text can be entered into the “Search text” field depicted in Figure 12 below that is situated above the “Recommend DATSs” button. When pushing this button, the tool will look for any DATS that has this text in its title, description or keywords.

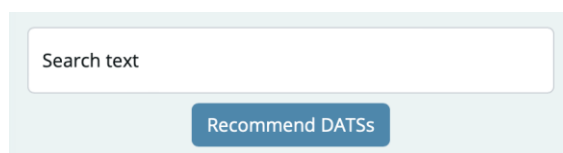
The image shows a user interface element consisting of a light blue rounded rectangle. Inside this rectangle, at the top, is a white rectangular input field with the placeholder text "Search text". Below the input field, centered horizontally, is a blue rectangular button with the text "Recommend DATSs" in white.

Figure 12. The Search text field for entering a natural language search text.

D3.7 QuantiFarm Toolkit – second version

DATS parameter filters

In the left-hand column of the “Recommendation” tab, specific values can be ticked for different DATS parameters as depicted in the Figure 13. The DATS parameters available here are the following:

1. agricultural sector
2. functionality
3. benefits
4. digital form
5. language
6. country
7. cost structure

The values for these parameters are the union of all possible values for the DATS available in the Recommendation Tool. When the “Recommend DATSs” button is pushed, only DATSs will be shown that have all the selected values as parameter values.

Recommend DATSs [Clear filters](#)

Agricultural sector

- Vegetables (73)
- Fruits and vines (53)
- Herbs (24)
- Plant production in general (86)
- Arable farming (93)
- [View more](#)

Functionality

- Plant protection management (156)
- Nutrition/Fertilisation management (155)
- Water management (127)
- Digital pest control (1)
- Rotary Parlor (1)
- [View more](#)

Benefits

- Optimization of resources use (282)
- Effective operational management (174)
- Efficient strategy planning (154)
- Enhanced adaptation & resilience to climate change (87)
- Environmental protection (183)
- [View more](#)

Digital form

- Mobile app (162)
- Web app (2)
- Stand-alone software (56)
- Web app (296)
- Webapp (2)
- [View more](#)

Language

- French (72)
- Basque (15)

Figure 13. DATS parameters to filter on specific values.



D3.7 QuantiFarm Toolkit – second version

Farmer profile information

Version 2.0 of the recommendation tool consists of an extended Farmer Profile. From the initial three farm characteristics (farm type, country, language) in the first release of the Recommendation Tool, the farmer profile is extended to include seven components:

1. farm type: arable, dairy, fruit, egg, arboriculture, meat, flower, other
2. farm location: ISO-3166 country code
3. preferred language: supported languages
4. desired functionality type: subgrouping of functionalities
5. desired achievement: preferred list of benefits
6. technological proficiency: computer software, mobile app, spreadsheet, paper
7. additional farm description: open text provided by the user for additional farm description.

This farmer profile can be entered on the top of the “Recommendation” tab as depicted in the following Figure 14 . It allows the user to provide more information about themselves and their wishes, and is supported by new and improved algorithms.

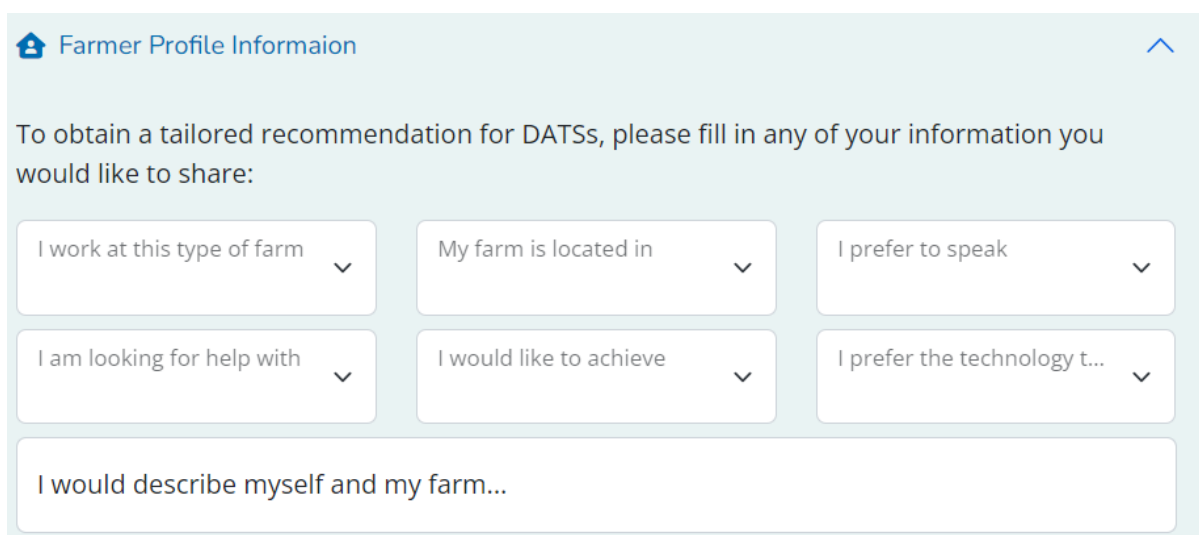


Figure 14. The extended farmer profile

When the “Recommend DATSs” button is pushed, only DATSs will be shown that match the values of the selected values of the farm/farmer characteristics.

Recommendation algorithms

A substantial upgrade of the Recommendation Tool Version 2.0 is the inclusion of various recommendation algorithms. On top of the already existing basic exact match algorithm, we have added two new algorithms to derive recommendations for non-exact matching DATSs. The first new algorithm is based on a meta-path structure calculation, counting different predefined paths within the provided DATSs knowledge graph supported by the QSCM ontology. The second new algorithm is based on a neurosymbolic approach, which uses natural language processing (NLP) to match the DATSs and the information of the farmer profile based on semantic similarity embeddings. These matching algorithms can be chosen by the user through an ‘advanced settings’ menu, as shown in Figure 15 below. The workings of each of the algorithms is explained in more detail below.



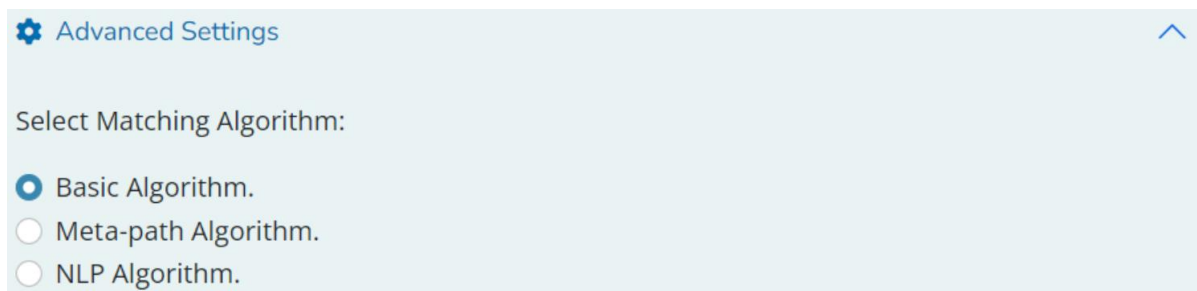


Figure 15. The matching algorithms as part of the advanced settings in the recommendation tool

Recommendation Algorithm - Basic: The basic recommendation algorithm takes all farmer profile input into account and for each of the selected information points, selects corresponding categories of the DATSs. With this, the Farm Type is connected to the targeted agricultural sector, the tech-savviness of the farmer is connected to the digital form, etc. For example, if a farmer selects ‘Arable Farm’ as its farm type, the model corresponds the selection with a myriad of hand-picked options of DATS sectors, among which “Vegetables”, “Arable farming”, and “Plant production in general”. Based on all of the filled-out farmer profile information, the model searches for DATSs that form an exact match to all of the required desires. Therefore, this version of the recommender system will only provide a recommendation of the DATSs that perfectly match everything the farmer requires. This is useful when the farmer knows exactly what they want, but runs the risk of not getting any recommendations while soft matches do exist in the database.

Recommendation Algorithm - Meta-path: Further continuing on the basic recommendation algorithm, the meta-path algorithm utilises the graph structure of the DATSs as stored according to the QSCM. This algorithm is based on earlier research¹ on knowledge graph based recommendation. This algorithm counts the amount of possible paths through the QSCM DATS knowledge graph between the Farmer Profile and each of the DATSs, and sorts the DATSs accordingly. A feature of this approach is that the graph and its semantics are being used to convey information of the correctness of the match, and leaves the possibility for the different DATS’s aspects to be weighted in importance. The main benefit of this approach in comparison to the basic algorithm is that this way the recommender system does take soft matches into account. This means that the DATSs are also recommended, even if some of the farmer profile aspects do not match up.

Recommendation Algorithm - NLP: The natural language processing (NLP) algorithm is implemented as a third algorithm and works for even more abstract soft matching. This algorithm encodes the information of the farmer profile and the information of the DATSs in a semantic model embedding. Different models for this exist, ranging from simple word2vec– embedders to powerful (and energy-consuming) SOTA large language models. For this particular task we have opted for the option between two mid-range language models, all-MiniLM-L6-v2² and Multilingual-E5-Large³, as these models are powerful enough to create the embeddings of short pieces of text. After embedding, a semantic similarity is calculated based on cosine similarity scores, and the most related DATSs are recommended. A beneficial feature of this algorithm is the support for free text, which allows the farmer to provide a full description of their farm in an additional field, which is used to strengthen the recommendation.

¹ Q. Guo et al., "A Survey on Knowledge Graph-Based Recommender Systems," in IEEE Transactions on Knowledge and Data Engineering, vol. 34, no. 8, pp. 3549-3568, 1 Aug. 2022, doi: 10.1109/TKDE.2020.3028705.

² <https://huggingface.co/sentence-transformers/all-MiniLM-L6-v2>

³ <https://huggingface.co/intfloat/multilingual-e5-large>

D3.7 QuantiFarm Toolkit – second version

When the “Recommend DATSs” button is pushed, the selected matching algorithm will be used to find matching DATSs.

Please note that the “Recommend DATSs” button can be pushed at any time and the tool will then use all the selected or entered values up to then to find the best matching DATSs to recommend.

Recommended DATSs result

The remainder of the user interface is used to present the selected DATSs and a short list of their parameters, i.e., the title, the agricultural sector, the functionality and the cost structure of the DATS as is shown in Figure 16.

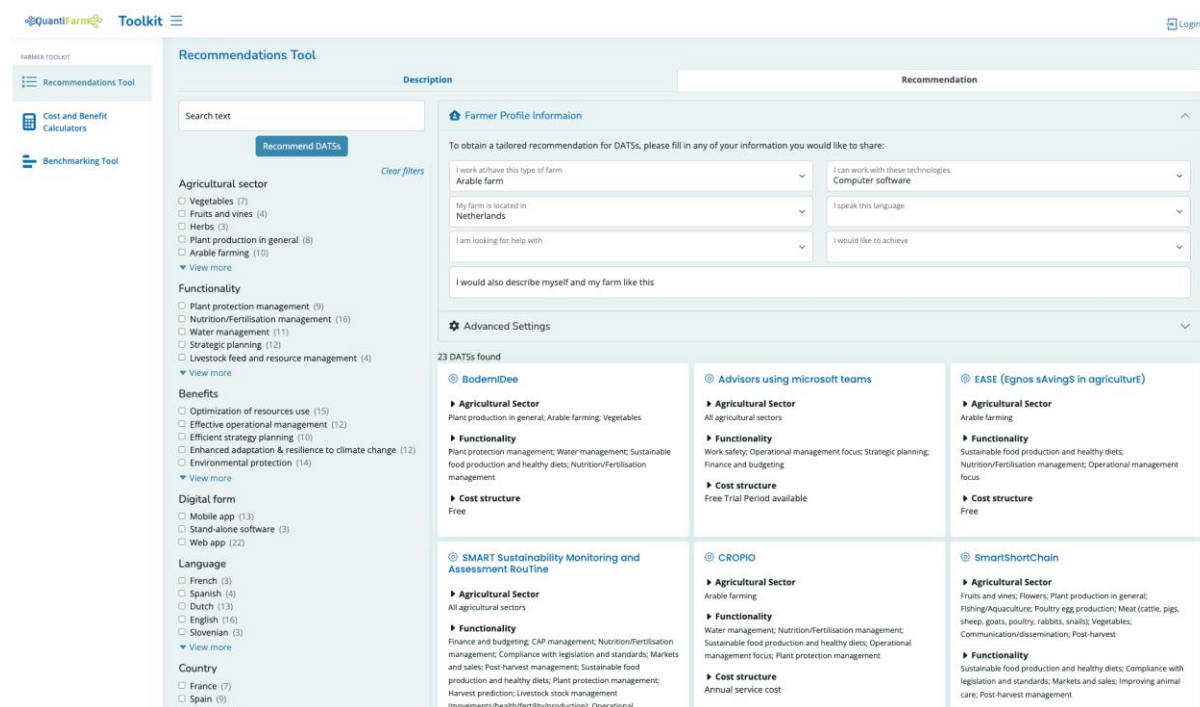


Figure 16. Screenshot of the main page of the QuantiFarm Recommendation Tool.

When clicking on one of the DATSs a pop-up window will appear that shows a longer list of DATS parameters and their values, including keywords, digital form, languages supported, countries of usage, launch year and a link to a website for even further information or possibilities to download or purchase the DATS. See Figure 17 for a screenshot of this pop-up window for one of the DATS.



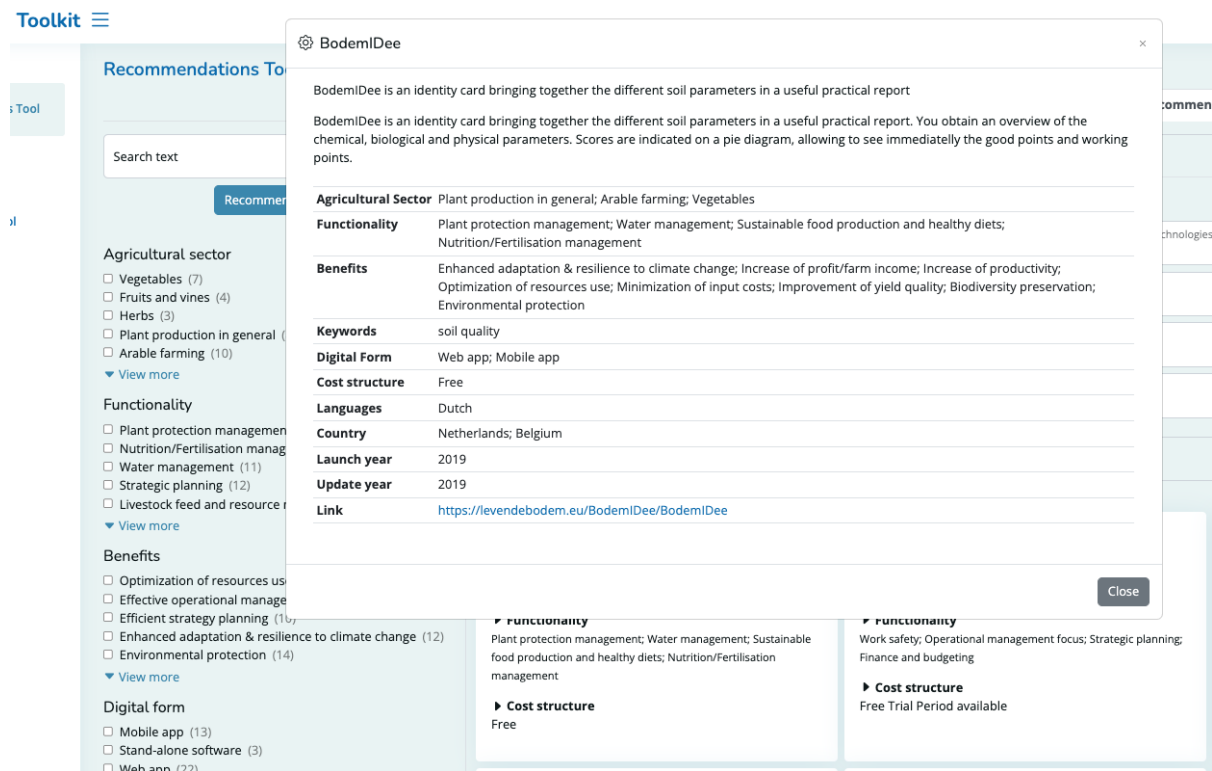


Figure 17. Screenshot of the pop-up for a DATS that shows more information about the DATS.

Last but not least, a recommendation also indicates for a DATS whether it has been or is being tested in a QuantiFarm testcase. This is indicated by a “TESTED” icon in the top right corner of the DATS overview page. In the pop-up window, it is indicated by a text saying in which testcases the DATS is used including a button per testcase to click on that brings the user to a webpage with more details about the results of the testcase. See Figure 18 for the pop-up window for a DATS that is used in testcase 9 and Figure 19 to see which kind of testcase assessment data is shown for a testcase.

Farm manager

ⓘ This DATS was tested in the following Test cases, click on the number to see more details: [📄 9](#)

Farm manager - farm business planning/modelling and decision-making for agricultural advisors, farmers and education

Farm Manager is the e-service for business planning, business modelling and decision-making on farms, based on a technically advanced e-service. It is a modern upgrade of the catalogue of calculations, which has historically been provided in the printed version, and has been an indispensable tool for planning business operations on farms for various purposes within the framework of agricultural consulting since 1995. The service enables users to review existing calculations and create farm production plans while advanced users (advisors) can develop and prepare new calculations. The Farm manager is, in the next iteration going to be upgraded into a data-driven platform, aggregating data received from satellites (Earth Observation), drones, in-situ sensors (IoT), weather stations, soil and plant test databases and other third-party/open data sources.

Agricultural Sector Farm-based added-value processes; Arable; Animal production in general; Plant production in general

Functionality Harvest prediction; Finance and budgeting; Nutrition/Fertilisation management; Livestock feed and resource management; FMIS/ Financial Modelling; Strategic planning; Operational management focus; Post-harvest management; CAP management

Benefits Better interaction between farmer and advisor; Biodiversity preservation; Efficient strategy planning; Environmental protection; Minimization of input costs; Financial assessment / Reporting; Effective operational management; Increase of profit/farm income; Increase of productivity; Task scheduling / Time management; Labour saving / Limit stress / Increase farmer's leisure time; Optimization of resources use

Keywords business planning; animal production; crop production; farm production; business modelling; decision support; farm manager

Digital Form Web app

Cost structure Free

Languages Slovenian

Country Slovenia

Launch year 2022

Update year 2022

Link <https://www.farm-manager.si/>

Close **TESTED**

Figure 18. Screenshot of the pop-up window for a DATS that is tested in a QuantiFarm Testcase.



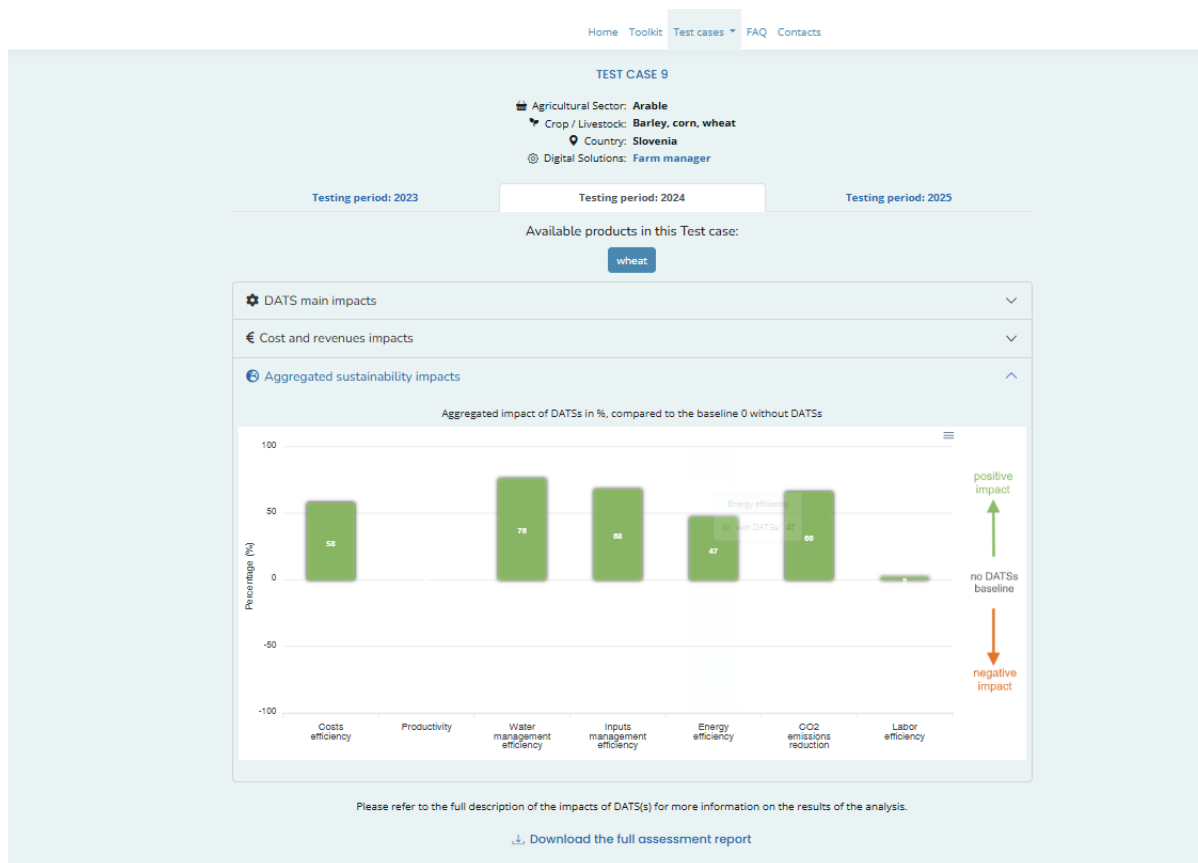


Figure 19. Screenshot of the results of a test case in which a DATS is being tested.

3.1.3 Next steps

At the time of writing (March 2025), only a few testcases have delivered complete testcase assessment data for 2024 (i.e., for the second piloting phase). One of the next steps is to incorporate this data into the process of generating a DATS recommendation. So, the DATS search process for a farm/farmer with a certain crop will be guided towards DATSs that had positive test results on a similar farm/farmer and crop. The test results include high level economic, environmental, and social sustainability as defined by the assessment framework, but also lower-level indicators around specific costs, benefits, resource usage etc. This is a technical and research challenge to be tackled in the second quarter of 2025.

Another step to be taken is to give a user-friendly explanation to the user why a DATS is suited best on the matching of parameters. This includes not only the direct matching of parameters, but also specific testcase results from which the user can benefit when using the DATS. Finally, the intention is to incorporate more available farm/farmer characteristics in the form of Farm Profile Personas together with WP1.

3.2 Benchmarking tool

3.2.1 Description

The “Benchmarking tool” aims to assist farmers and advisors in recording digitally the cultivation practices and to automate the calculation of important and useful performance indicators. It also offers the option to compare calculated indicators from different farms and/or for different cultivation periods. The tool also includes information about the DATs that have been utilised and are associated with specific farming activities allowing the user of the “Benchmarking tool” to correlate performance with agricultural technology solutions. This allows the extraction of conclusions on the usefulness and the applicability of DAT in specific contexts.

3.2.2 Benchmarking tool Dashboard/GUI

The Benchmarking Tool Version 2.0 has been updated to a) incorporate data from real farm calendars provided by TC11 that will serve as reference files for comparisons and b) include additional environmental measurements such as temperature, humidity, wind strength, leaf wetness and rain. These example datasets have been anonymized and filtered for any sensitive data and include real-world recordings of activities such as irrigation, fertilization, and pesticide applications and output results including harvest data. All data are formatted in CSV files that follow the structure outlined in the “Download example files” section available on the tool’s webpage “description” tab: <https://quantifarmtoolkit.eu/tool3.html> (Figure 20). Those example files will be useful for comparisons closer to real farming conditions and decision-making needs but also can help facilitate demonstration events of the tool in the future.”

The Benchmarking tool has undergone significant improvements from the previous version, including 1) bug fixes and user interface enhancements, 2) supports a broader range of analytics and aggregate data processing, 3) better usage examples are now available, using real pilot data.

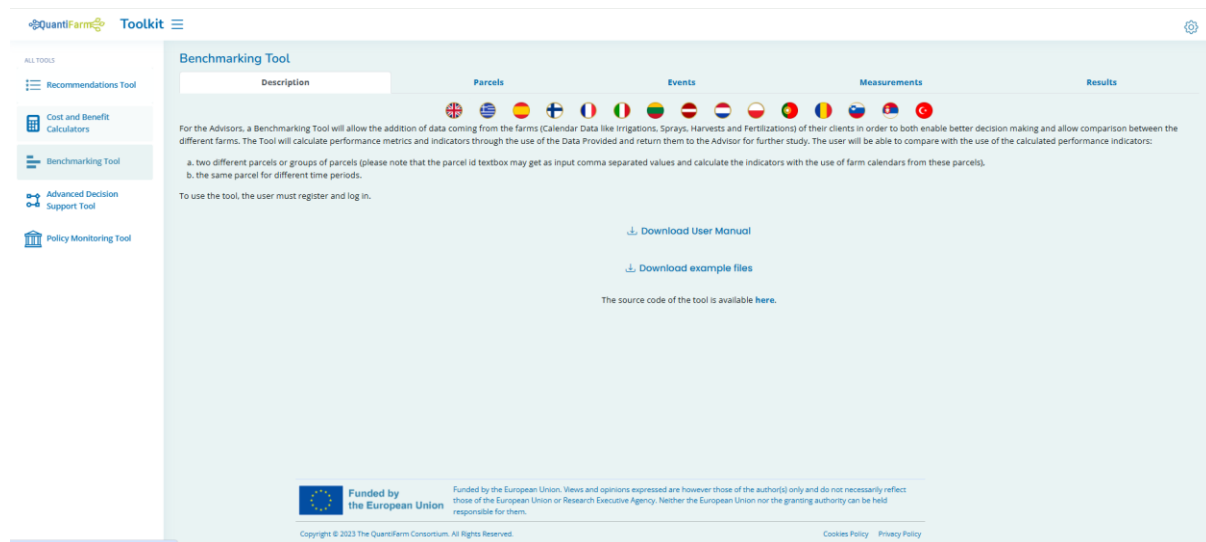


Figure 20. User Interface of the Benchmarking Tool <https://quantifarmtoolkit.eu/tool3.html>. Option to download example files is visible

The tool requires the user to create an account and to specify username and password. This is a necessary step because this tool maintains sensitive data about the farming practices (farm calendar) that have been applied and because [data persistence](#) significantly improves the utilisation efficiency of the tool.



D3.7 QuantiFarm Toolkit – second version

After login the first step for using this tool is the user to create a parcel by providing the appropriate info in the system through the “Parcels” Tab. This is realised by providing:

- Parcel Name
- Parcel Polygon

The Polygon must be expressed in [GeoJSON](#) coordinates format. An easy way to create this type of geometry/coordinates is available [here](#). In this updated version of the tool, the process of defining the polygon is further automated as there is the option to draw it on the map (Figure 21).

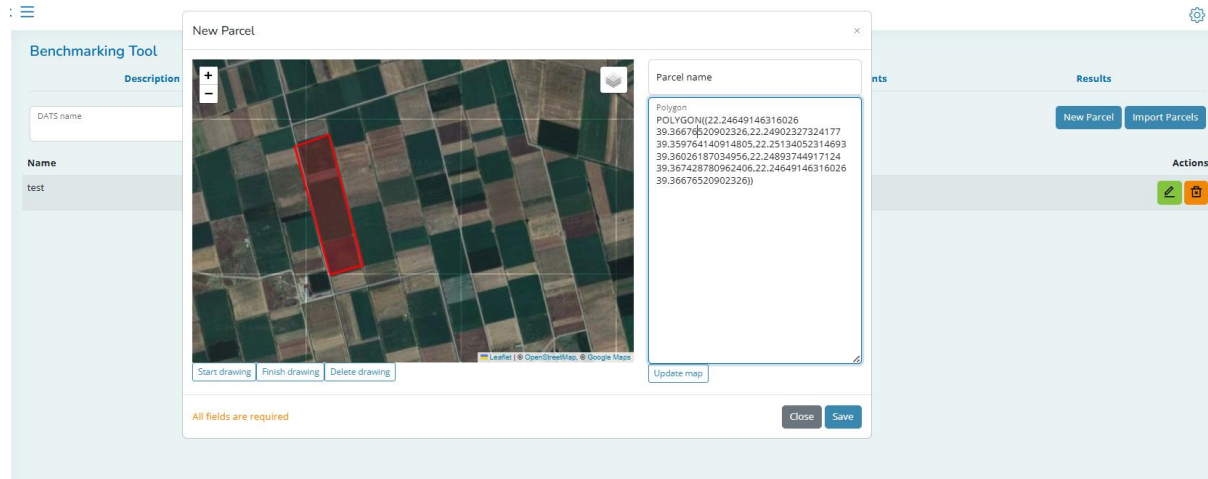


Figure 21. Create a new Parcel

After the creation, of the full list of available Parcels are listed. The user can either Edit or Delete an existing parcel.

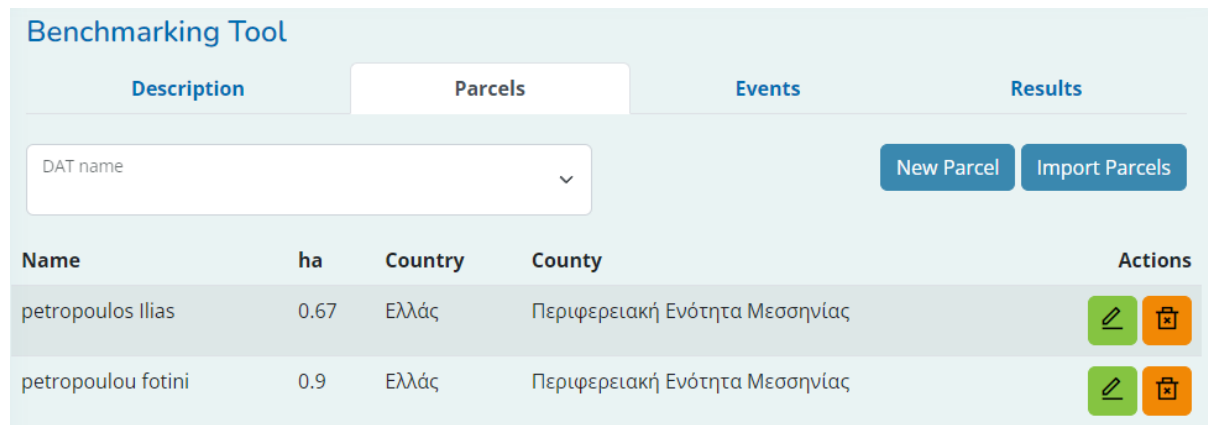


Figure 22. List of available parcels.

Next the user must add “Calendar Events” through the “Events” Tab referring to farming activities performed in a specific parcel. Data input is realised through a form where various fields are required (Figure 23). It is also feasible the user to import a list of events by uploading a CSV file. This allows the “Advisors” to use their own system (e.g. a digital farm book using a spreadsheet like MS Excel), export the list of performed farming activities in CSV and upload to the “Benchmarking Tool”.



D3.7 QuantiFarm Toolkit – second version

New Event
×

Parcel

DATs

Event start
mm/dd/yyyy --:-- --

Event end
mm/dd/yyyy --:-- --

Duration

Type

Crop

Variety

Target

Product

Stage

Amount

Unit

Ref

Substance

Fuel consumption

Fuel type

Unit

Ref

Comments

All fields, except Comments are required

Close

Save

Figure 23. Adding entries to the digital farm calendar.

After successfully filling the events, they will also be displayed in a List and the user will again be able to Edit or Delete them at will.

Benchmarking Tool

Parcel name

Event type

Event start
mm/dd/yyyy

Event end
mm/dd/yyyy

New Event

Import Events

Type	Event start	Event end	Parcel name	Actions
spray	2022-01-15 00:00	2022-01-15 00:00	Parcel_3	✎ ✖
spray	2022-02-22 00:00	2022-02-22 00:00	Parcel_3	✎ ✖
spray	2022-02-22 00:00	2022-02-22 00:00	Parcel_3	✎ ✖
spray	2022-02-26 00:00	2022-02-26 00:00	Parcel_3	✎ ✖

Figure 24. A list of performed farming activities.

The next step is that the user must add measurements (temperature, humidity, rain, etc.) through the “Measurements” Tab referring for a specific parcel. Data input is realised through a form where various fields are required (Figure 25). It is also feasible the user to import a list of measurements by uploading a CSV file. This allows the “Advisors” to use their own system (e.g. a digital farm book using a



D3.7 QuantiFarm Toolkit – second version

spreadsheet like MS Excel), export the list of performed farming activities in CSV and upload to the “Benchmarking Tool”.

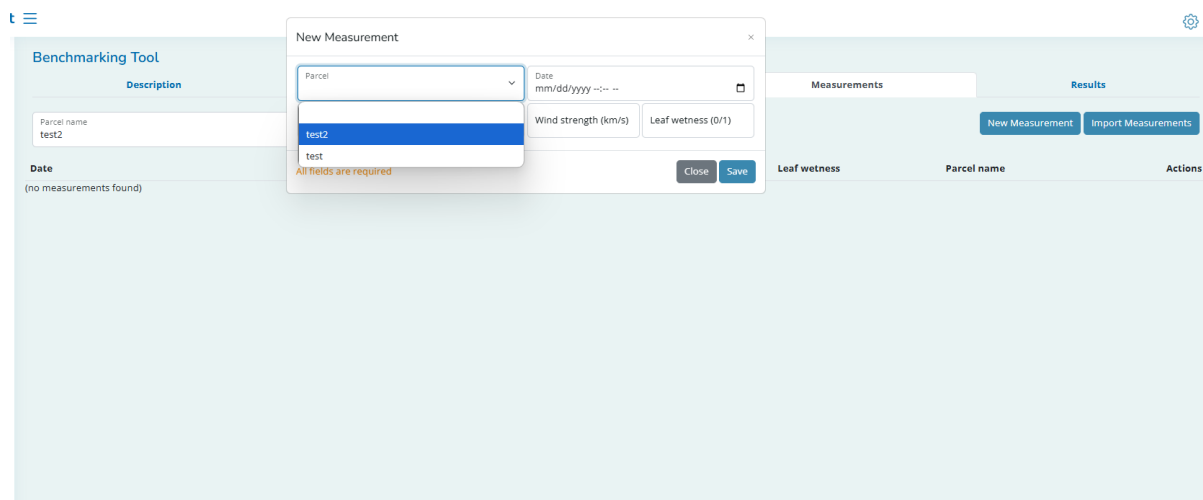


Figure 25. Adding measurements to the digital farm calendar.

After successfully filling the measurements, they will also be displayed in a List and the user will again be able to Edit or Delete them at will.

Date	Temperature	Humidity	Wind strength	Leaf wetness	Rain	Parcel name	Actions
2024-01-01 00:00	12.85	95.83	0.35	1	2	P21 Nederland	
2024-01-01 01:00	12.43	96.67	1.28	1	2	P21 Nederland	
2024-01-01 02:00	13.03	93.83	2.42	0	0	P21 Nederland	
2024-01-01 03:00	13.88	89	2.1	0	0	P21 Nederland	
2024-01-01 04:00	14.12	86.83	2.13	0	0	P21 Nederland	
2024-01-01 05:00	14.18	85.33	2.5	0	0	P21 Nederland	
2024-01-01 06:00	13.65	87.5	0.82	0	0	P21 Nederland	
2024-01-01 07:00	13.67	85.33	3.02	0	0	P21 Nederland	
2024-01-01 08:00	14.23	81.33	5.05	0	0	P21 Nederland	
2024-01-01 09:00	14.55	77.17	4.07	0	0	P21 Nederland	
2024-01-01 10:00	15.15	76.67	3.82	0	0	P21 Nederland	

Figure 26. A list of measurements.

When all data are present in the system the user can proceed with initiating the calculation of the benchmarking results by navigating to Tab “Results”. Aggregation Results can be one of the following:

- **SUM** (Summary of the Values provided for specific Calendar Event)
- **MIN** (Minimum of the Values provided for specific Calendar Event)



D3.7 QuantiFarm Toolkit – second version

- **MAX** (Maximum of the Values provided for specific Calendar Event)
- **AVG** (Average of the Values provided for specific Calendar Event)

Also, regarding the measurements

- **MIN, MAX, SUM** per month and aggregation per cultivation period.

Benchmarking Tool

Description **Parcels** **Events** **Results**

The user will be able to compare with the use of the calculated performance indicators:

- two different parcels or groups of parcels (please note that the parcel id textbox may get as input comma separated values and calculate the indicators with the use of farm calendars from these parcels),
- the same parcel for different time periods.

Event type: fertilization

Aggregation Summary

Parcels group 1: petropoulos Ilias

Parcels group 2: petropoulou fotini

Event start: mm/dd/yyyy Event end: mm/dd/yyyy

Compare

Substance name	Total	Unit	per ha	ha
11-15-15	13400	gr	20000	0.67

No DATs used

Substance name	Total	Unit	per ha	ha
11-15-15	26100	gr	29000	0.9

DATs used:

gaiasense

Gaiasense, an innovative smart farming system designed and developed by NEUROPUBLIC S.A., collects data from the field (atmospheric and soil data), the satellite (Earth Observation data), the scientist (on farm observations, measurements and sampling) and the farmer (recording of farming

Figure 27. Calculated farming performance indicators



D3.7 QuantiFarm Toolkit – second version

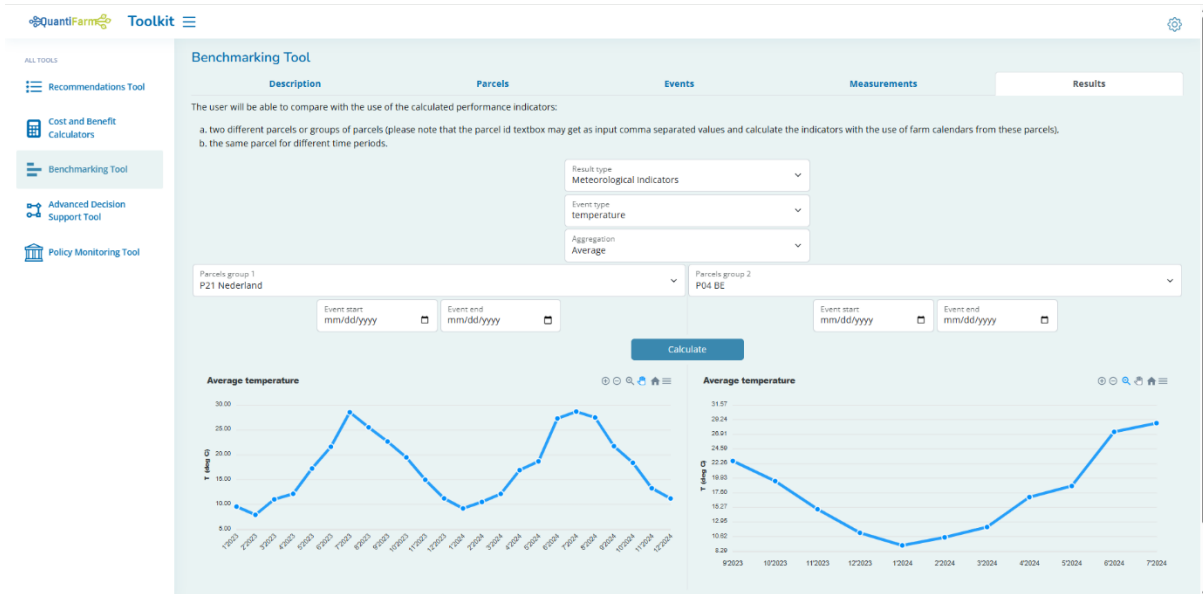


Figure 28. Calculated indicators for measurements

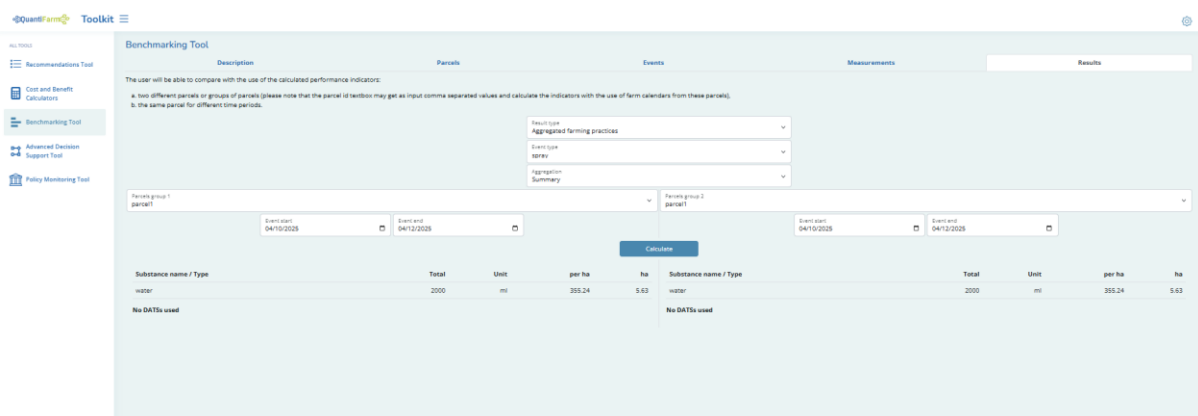


Figure 29. Calculated indicators for farming practices (spraying)

3.2.3 Next steps

The next steps would be addressing any operational issues or bugs that may arise and finalizing the process of integration with TCs data. The tool can automatically check the database for any DATs that have already undergone assessment in the same region or for the same crop type. By pulling in these matching records, the system ensures that any subsequent analysis or recommendations are built on directly comparable data.



3.3 Cost benefit calculator tool

3.3.1 Description

The 'Cost & Benefit Calculator' tool is designed to assist farmers and agricultural advisors in analysing the financial implications and potential benefits of integrating various DATSs into their farming operations. This integrated tool adeptly meets the diverse requirements of both crop and livestock farming systems, featuring specific calculator modules tailored for each.

The tool's latest version (v2) includes two main repositories of DATSs for end users:

- The **first repository** contains commercially available DATSs for crop and livestock farming systems, identified through the literature review conducted under Task 2.3. This review not only compiled relevant DATSs but also collected associated cost and benefit data by leveraging previous EU projects such as *Fairshare* and *SmartAkiS*, as well as scientific publications and available materials from technology providers (e.g., leaflets, brochures, reports). This repository is accessible by selecting the “**DATs for Crop Farming Systems**” or “**DATs for Livestock Farming Systems**” options.
- The **second repository** focuses on the DATSs implemented and tested within the project's Test Cases. The data for these DATSs were generated from internal analysis carried out in WP2 based on the Test Cases' results. This repository is accessible via the “**Test Case's DATSs**” button.

An overview of the tool's main entry page and its navigation layout is presented in Figure 30, which shows the interface where users can select between the two repositories and proceed with the relevant calculations.

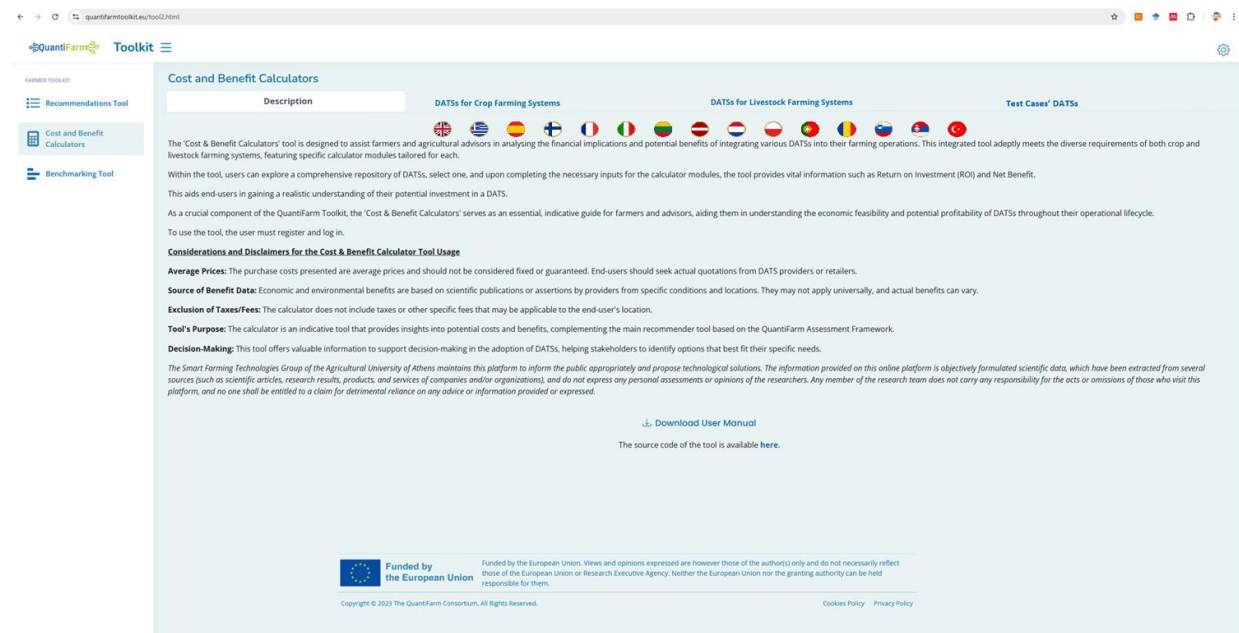


Figure 30. Cost and Benefit Calculator tool main entry page.

Within the tool, users can explore either repository, select a DATS, and, by completing the required input fields, receive insights into investment costs, labour, fuel and cost savings, and other parameters



D3.7 QuantiFarm Toolkit – second version

potentially influenced by DATS adoption. The tool also provides estimations for key financial indicators such as Return on Investment and Net Benefit, which users can further explore by adjusting the number of years they plan to use the selected DATS. The Cost & Benefit Calculator is designed to give end-users a realistic, monetary-based understanding of what each DATS can offer, ultimately supporting them in making informed decisions about potential investments. As a key component of the QuantiFarm Toolkit, it serves as a practical and indicative guide to help users evaluate the economic viability and long-term profitability of digital technologies in agriculture.

The “Cost & Benefit Calculator” tool, as described, offers a comprehensive approach to understanding the financial aspects of DATSs in both crop and livestock farming systems. While this tool provides significant insights, it is equally important to consider certain limitations and practical aspects of its usage. To this end, we have outlined a series of key considerations and disclaimers. These are presented in the Table 1 below and cover a range of important factors including average pricing, data sources, and the exclusion of specific costs. This information is crucial in ensuring users have a realistic expectation of the tool's capabilities and can interpret its results within the correct context. It is recommended that all users familiarise themselves with these considerations and disclaimers to enhance their understanding and application of the “Cost & Benefit Calculator” tool as part of their decision-making process.

Table 2 Considerations and Disclaimers for the Cost & Benefit Calculator Tool Usage.

Considerations and Disclaimers for the Cost & Benefit Calculator Tool Usage	
Consideration/Disclaimer	Details
Average Prices	The purchase costs presented are average prices and should not be considered fixed or guaranteed. End-users should seek actual quotations from DATS providers or retailers.
Source of Benefit Data	The economic and environmental benefits presented are derived from scientific publications, provider claims under specific conditions and locations, and results obtained from the project's Test Cases. These benefits are not universally applicable and may vary significantly depending on factors such as crop type, field conditions, geographic region, and farming practices.
Exclusion of Taxes/Fees	The calculator does not include taxes or other specific fees that may be applicable to the end-user's location.
Tool's Purpose	The calculator is an indicative tool that provides insights into potential costs and benefits, complementing the main recommender tool based on the QuantiFarm Assessment Framework.
Decision-Making	This tool offers valuable information to support decision-making in the adoption of DATSs, helping stakeholders to identify options that best fit their specific needs.



3.3.2 Cost benefit calculator tool Dashboard/GUI

The “Cost & Benefit Calculator” tool is specifically designed to support farmers and agricultural advisors in evaluating the financial implications and benefits of incorporating DATSs into their farming operations. In this second version of the tool, user must first indicate whether he wish to explore DATSs identified through the literature review or DATSs tested within the project's Test Cases.

To begin, users can select one of the following three main options:

- “DATSs for Crop Farming System”
- “DATSs for Livestock Farming System”
- “Test Cases’ DATSs”

This initial selection is illustrated in Figure below.



Figure 31. DATS repository selection - Initial selection screen where the user chooses between literature-based or Test Case DATS.

If the user selects either Crop or Livestock Farming System from the literature review, the next step involves choosing the crop type (Arable, Fruits, Vineyards, Vegetables, Orchards) or the animal type (Cattle, Pigs, Poultry, Small Ruminants), as shown in Figure 32.

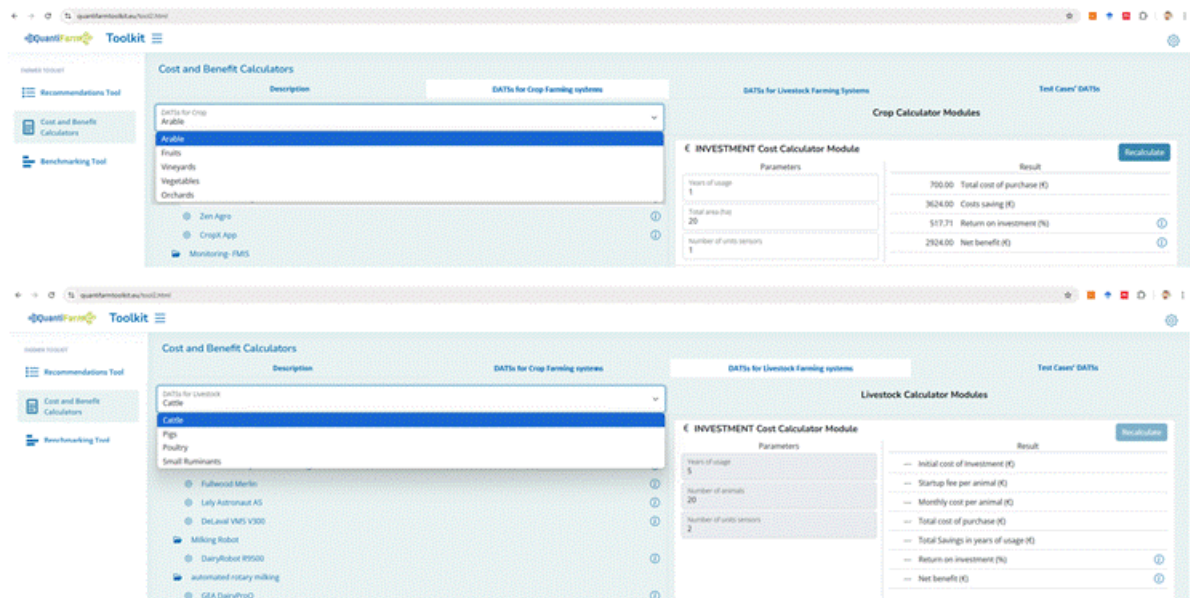


Figure 32. Crop or Animal Type selection - Users specify the farming system of interest.

Following this, the user is prompted to select a DATSs category relevant to the crop or livestock system (Figure 33), and then proceed to select a specific DATS for further analysis (Figure 34).



D3.7 QuantiFarm Toolkit – second version

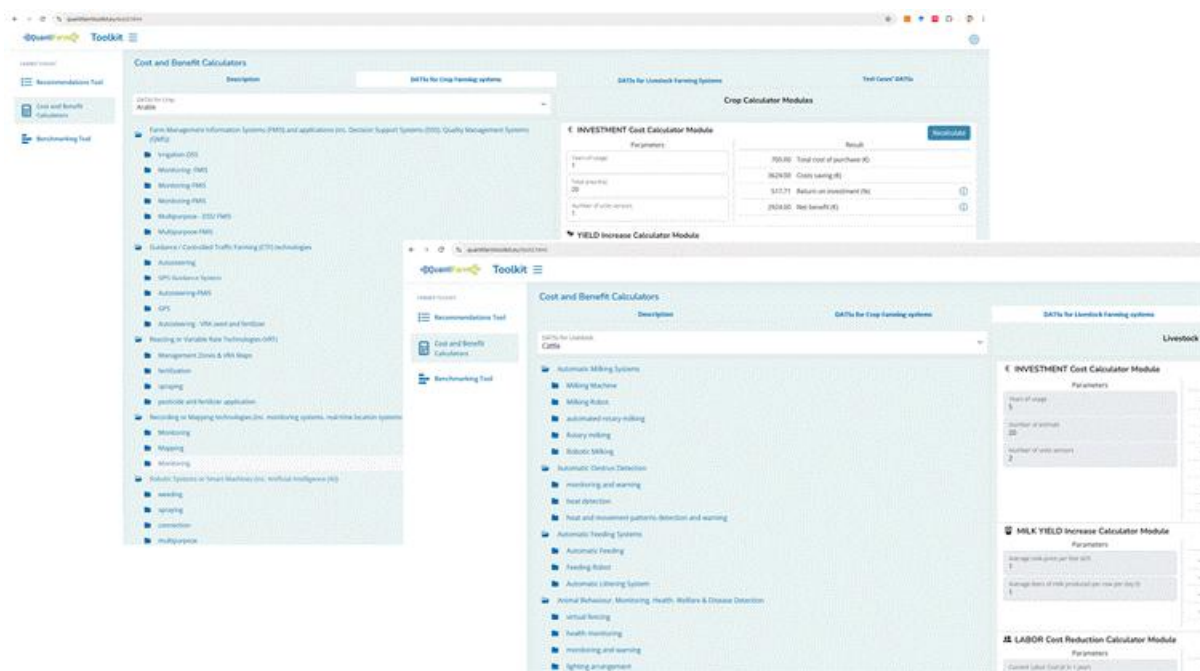


Figure 33. DATs category selection - Categorisation based on farming system.

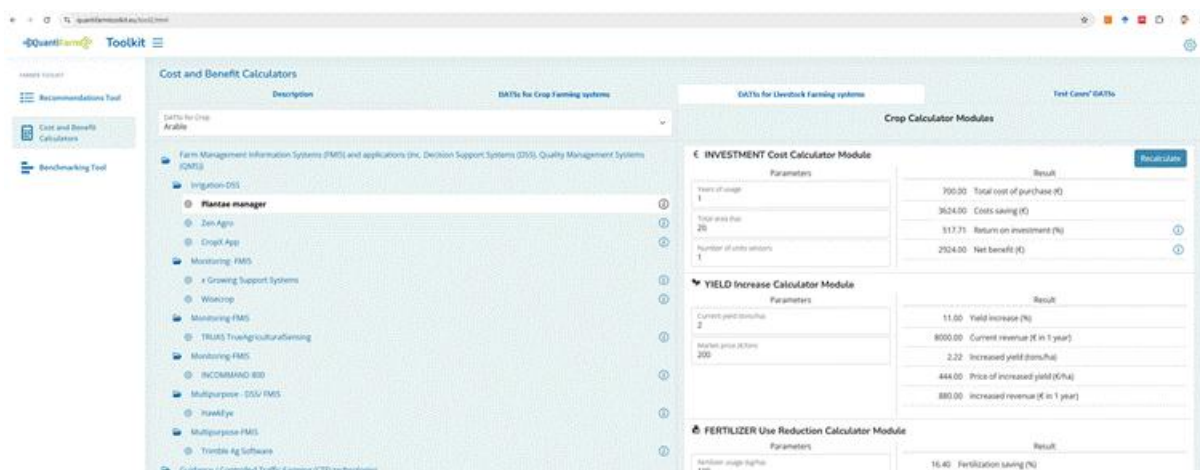


Figure 34. DATs selection for analysis - Users choose a specific DATs to explore cost-benefit metrics.

Next to each DATs, an information icon (i) is provided, which users can click to access key details about the technology. This includes the DATs name, provider, purpose, and an average estimate of investment cost. An example of this information display is shown in Figure 35 using the “CropX App”.



D3.7 QuantiFarm Toolkit – second version

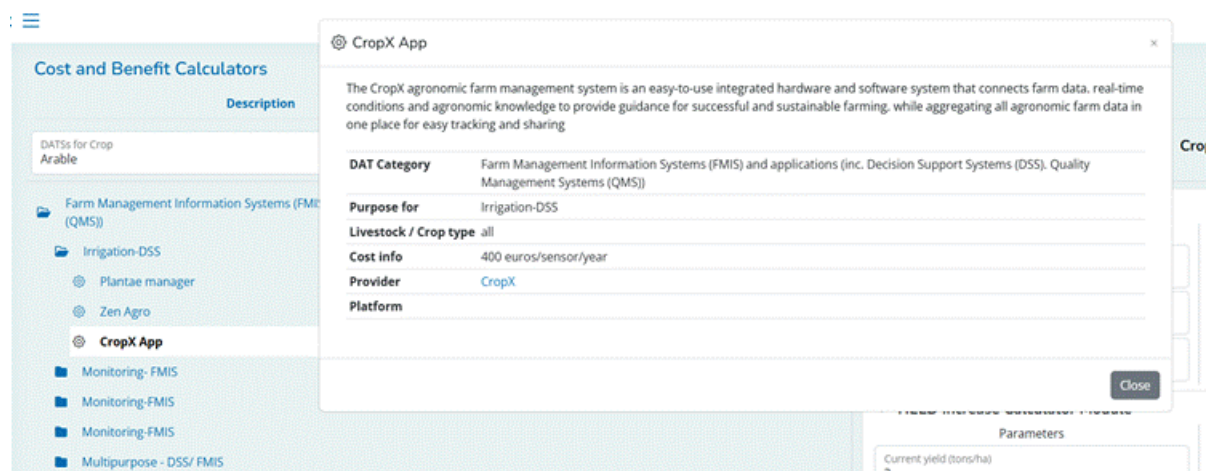


Figure 35. DATS Information Window – Example from CropX App - Informative pop-up providing key insights for user decision-making.

If the user instead selects the “Test Cases’ DATs” option, the tool guides them to choose between Crop-based or Livestock-based Test Cases (Figure 36 and Figure 37). In this case, the crop or animal type is not selected by the user, as each Test Case already involves a specific farming system. Users can then continue by selecting the relevant DATS category and proceed with the analysis.

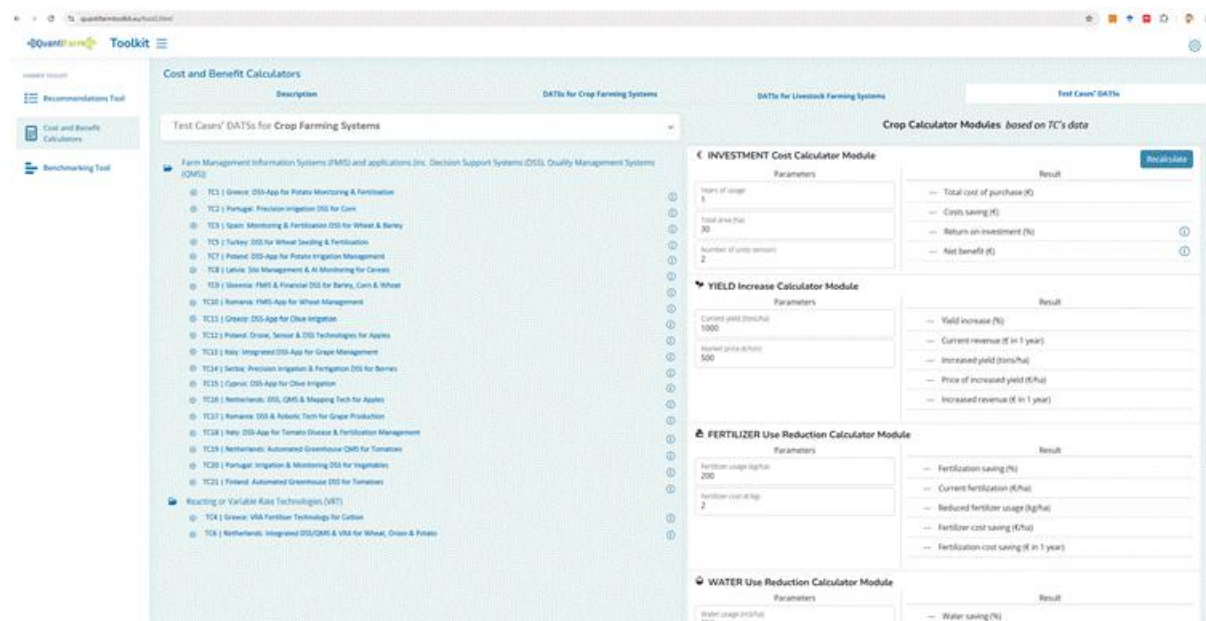


Figure 36. Crop-based Test Case's DATs Selection - Selection interface for DATs implemented in crop-based Test Cases.



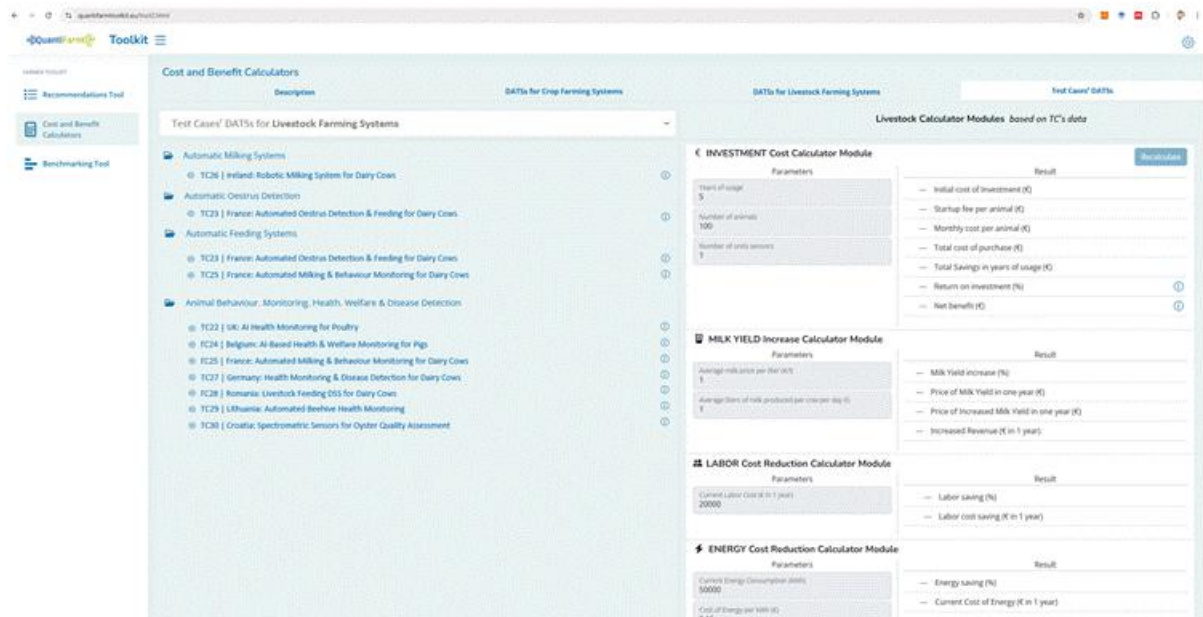


Figure 37. Livestock-based Test Case's DATSs Selection - Selection interface for DATSs implemented in livestock-based Test Cases.

Once a DATS is selected, users initiate the evaluation process by activating the calculator modules, which are tailored to the type of farming system crop, livestock, or Test Case-specific DATSs. The tool prompts users to input essential information such as the number of usage years, units adopted, and key operational metrics including area, yield, and associated costs. These inputs are fundamental for enabling the tool to perform an accurate and comprehensive cost-benefit analysis.

The system then processes the data through dedicated calculator modules designed to assess various dimensions of the DATS's performance. These include calculations of investment costs, operational savings, and potential revenue increases. The outputs generated, such as Return on Investment and Net Benefit, are presented in a user-friendly format, accompanied by clear guidance to support interpretation. Users also have the flexibility to adjust parameters, such as the number of usage years, to explore different scenarios and evaluate potential outcomes under varying conditions.

3.3.3 Next steps

The project's core functions are established. Future tasks will focus on adding new data from analysis of the upcoming season's TCs outcomes, if available and suitable. Updating the calculator modules with this data will keep the solution reliable. It's also crucial to monitor system performance, fix any bugs quickly, and ensure the toolkit's calculations remain reliable for users.



3.4 Advanced decision support tool for the selection of Digital Technologies for agriculture

3.4.1 Description

The objective of the tool is to help advisors support their customers in deciding which DATS is most appropriate for their farm, through a robust decision-making process. This tool was finalized on the previous release of the “QuantiFarm toolkit” and no more changes occurred in this release apart from the translations in different languages.

The “Advanced decision support tool” aims to support advisors and farmers on the selection of the most appropriate DATS under each given set of conditions, building on a combination of Strategic Fit, Analytic Hierarchical Process (AHP) and Quality Function Deployment (QFD) methods⁴. It was designed to address one of the key barriers in adopting digital technologies, which is the lack of knowledge and evidence regarding their (direct and indirect) actual benefits and costs. The first step of the tool uses strategic fit as a filter to exclude the services that do not comply with the farm's strategic goals. The second step uses QFD to evaluate the services based on customers’ and partners’ needs. The third step uses AHP to break down the problem to a hierarchical model which includes several criteria identified using the Technology, Organization, Environment (TOE)⁵ framework in the agri-food value chain.

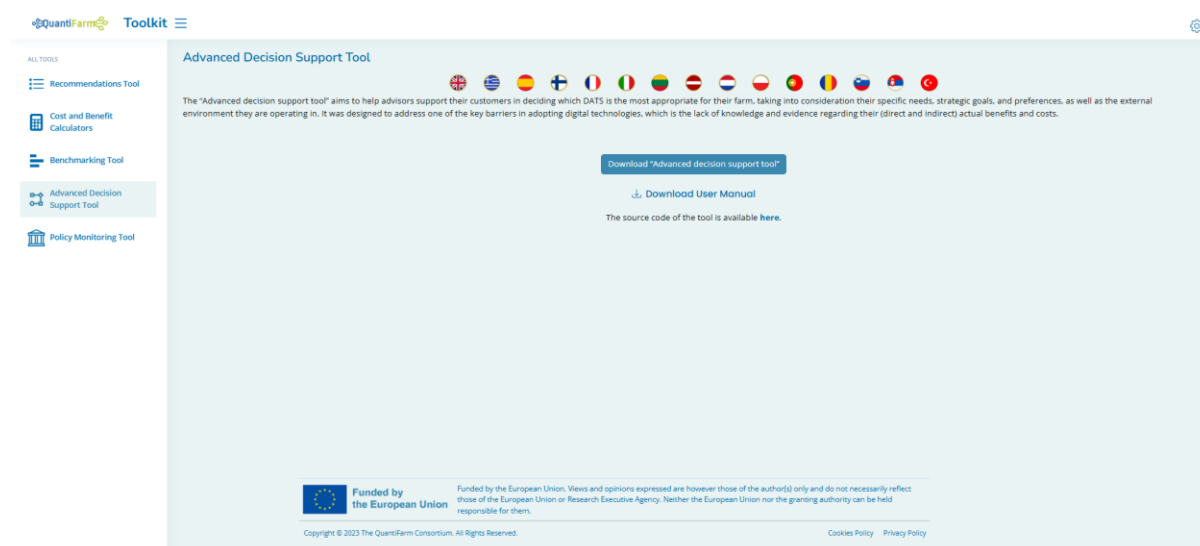


Figure 38. The «Advanced decision support tool» page.

Two versions of the tool are available to the advisor. The first version is a more complicated version that uses the full power of AHP method and provides the best possible results but it's more difficult and time consuming to complete. This version is available in xlsx format and available for offline use. The excel file is available for download and use through the tool's page (Figure 38).

The second version of the advanced decision support tool is based on a simpler process that is easier to be completed but creates somewhat less accurate (but still absolutely valid) results. This version that will be implemented as a web app in the Toolkit and that can be used online is under development.

⁴ Marianos, N., Lambrou, M.A and Spyrou, D. (2011), “Evaluating electronic port services for container terminals: the PPA case”, Int. J. Decision Sciences, Risk and Management, Vol. 3, Issue 3/4, pp. 347-368

⁵ Tornatzky, L. G. and Fleischer, M. (1990) The Process of Technology Innovation, Lexington, MA: Lexington Books.



3.4.2 Directions of use

The problem to be solved by the tool is defined as the selection of the DATS with the biggest value to the farm. To select the best solution, all the possible alternatives have to be identified first. Based on the farmer’s profile and location, the available possible alternative DATs are presented to the advisor by the system. The alternatives that are not suitable with the business strategy, the organisational goals and the needs of the farmer, must be eliminated. The strategy of the examined farm/farmer is broken down to a set of specific organisational strategy goals that have to be defined in order to be used to evaluate the alternatives. This is done by selecting from a list of pre-defined criteria that were defined in the tool, i.e. 1) Cost Reduction, 2) High Quality Products, 3) Competitive Advantage, 4) Farm Growth/Development, 5) Economic Sustainability, 6) Environmental Sustainability, 7) Risk Reduction, 8) Ecosystem Services/Added Value Services, 9) Succession and 10) Innovation. Then, with the help of the advisor, the farmer assigns relative weight to each selected goal (where the relative weights of all goals sum to 1). Each alternative is then evaluated using a scale from 1 to 5 (where 1= very poorly and 5=very well) according to how well it fulfils each strategic goal (this is done by the advisor supporting the process, who has the appropriate knowledge). The final strategic fit score of an alternative is measured as the sum of the score on fulfilment of each of the strategic goals multiplied by the relative weight of this goal (e.g. $SFA = 0,25*4 + 0,25*3 + 0,1*3 + 0,1*3 + 0,15*4 + 0,15*2 = 3,25$). Alternatives with a score equal or better than 3, are qualified to the next phase. Alternatives with scores less than 3 are disqualified.

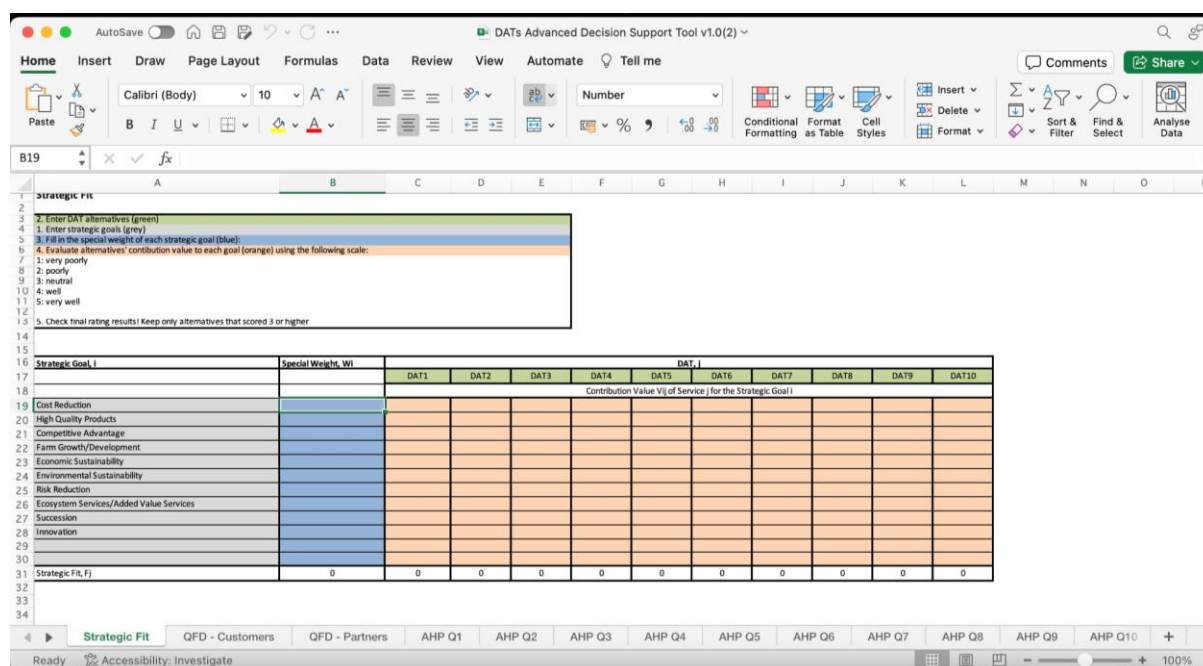


Figure 39. The «Advanced decision support tool» available in Excel.

In the second step, a light version of QFD is used to let the farm’s customers and partners (including retailers, food processing companies, intermediaries and/or consumers) evaluate the services and to correlate their needs with the needs of the farmer. This is done by selecting from a list of pre-defined needs that were defined in the tool, i.e. 1) Product Cost Reduction, 2) Yield Quantity Consistency, 3) Information Accuracy/ Traceability, 4) High Food Quality/Specific Quality Characteristics and 5) Sustainability. A 3 point scale (strong (5), average (3) or weak (1)) is used to evaluate the customer satisfaction for each of the documented needs/demands. The evaluation scores are used in the next phase and used as input for the calculation of the AHP model.



D3.7 QuantiFarm Toolkit – second version

In the third step, the final step of the evaluation of the selected alternative solutions is being completed with the use of AHP. In this step, the system (or the advisor supporting the process) selects the appropriate evaluation pre-defined criteria which cover all aspects of the problem (i.e. “Technology Characteristics”, “External Environment”, “Organizational Maturity/Internal Environment”, “Perceived Benefits” and “Costs”) and the farmer (with the help of the advisor that supports the process) assigns special weights to each criterion in order to evaluate each alternative. To achieve that, the farmer performs pairwise comparisons to examine the relative priority of each criterion of a level regarding the higher level of the model. Based on these comparisons, the system produces a final score. The solution with the highest score is the most appropriate one for the farmer.



3.5 Policy Monitoring Tool

3.5.1 Description

The Policy Monitoring tool provides policy makers with a visual policy monitoring dashboard, allowing the generation of analytical reports based on queries, including summary tables as well as graphical charts. Through an incremental and iterative methodological approach, the tool will continuously incorporate more data and update the existing with more accurate datasets wherever feasible, ensuring that policymakers have access to up to date and comprehensive information. This evolving data landscape enhances the tool's ability to support a well-grounded link between agricultural policies and a spatially and temporally heterogeneous set of data, enabling policymakers to make decisions that are both data-driven and closely aligned with the dynamic nature of agricultural ecosystems. In detail, we integrate and render on a regional ([Local Administrative Unit - LAU](#) or [Commune](#)) level data derived from anonymized and aggregated in-situ information from 12 selected QuantiFarm test cases. This includes information from parcels utilising DATSs, parcels not employing DATSs, parcels not employing DATSs, farm calendar exports, and digital logs. EO data products (e.g. crop type, land use), open European GIS datasets (e.g. GISCO⁶, EEA⁷) and open data from EU policy monitoring services (e.g. FADN⁸, Eurostat) have been used as inputs to calculate indicators (KPIs), variables or setting thresholds for subjective qualitative and quantitative comparisons of regional performance related to local and EU policy implementation.

In the previous version (v1), the Policy Monitoring Tool could provide analytics for a crop area of 71,601.94 hectares. Following the latest update (v2), it now supports analytics for a significantly larger crop area of 158,804.03 hectares.

3.5.2 Policy Monitoring Tool Dashboard/GUI

Users can access the new version (v2) of the policy monitoring tool via the QuantiFarm toolkit main page as depicted below (Figure 40) by clicking the “Policy maker” icon or the “toolkit” tab.



Figure 40. The QuantiFarm toolkit main page

⁶ <https://ec.europa.eu/eurostat/web/gisco>

⁷ <https://www.eea.europa.eu/en>

⁸ https://agriculture.ec.europa.eu/data-and-analysis/farm-structures-and-economics/fadn_en



D3.7 QuantiFarm Toolkit – second version

The 'toolkit' tab also redirects to the page <https://quantifarmtoolkit.eu/toolkit.html> that all tools are listed as shown below (Figure 41).

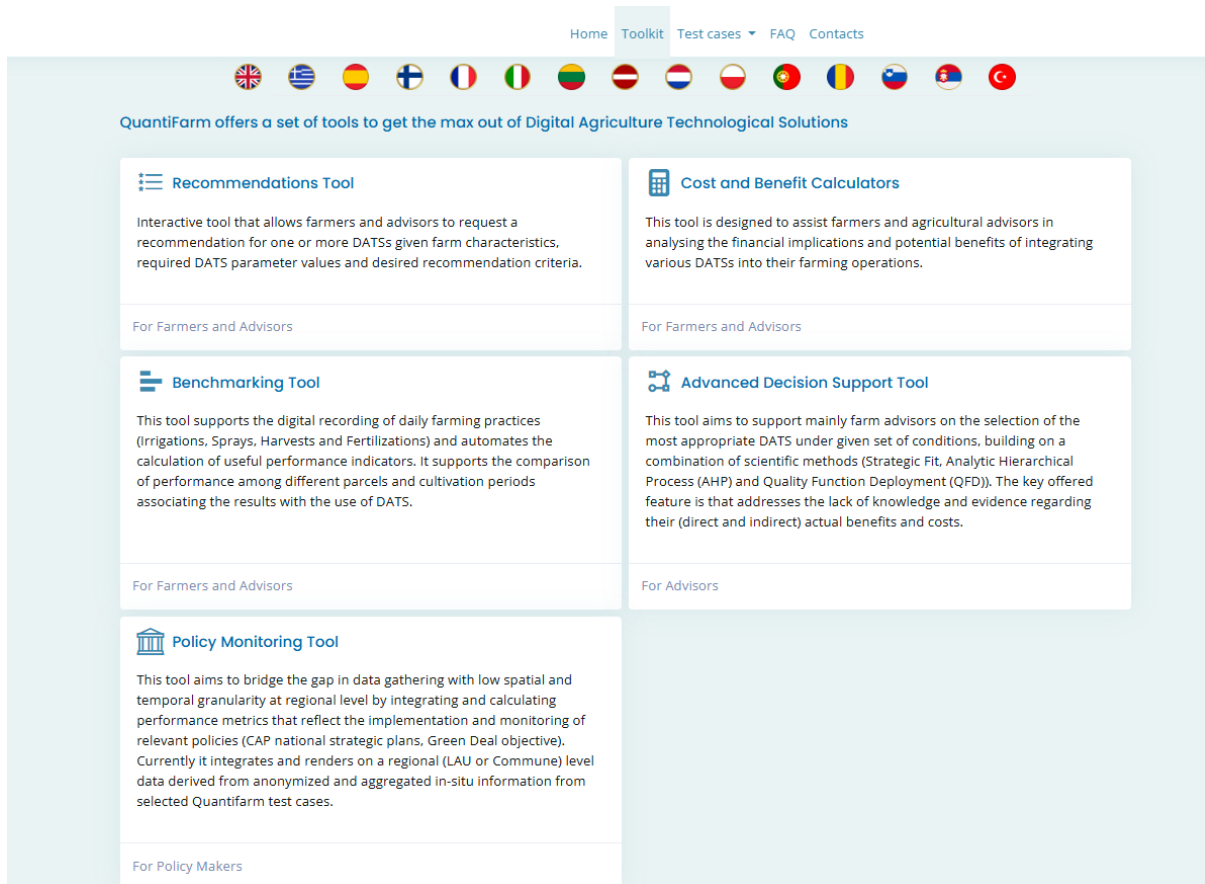


Figure 41. The toolkit tab (<https://quantifarmtoolkit.eu/toolkit.html>).

Upon clicking on the "Policy monitoring tool", the user is redirected to the URL: <https://quantifarmtoolkit.eu/tool6.html>, which leads to the page providing a detailed description of the tool, while the corresponding button (Figure 42) redirects to the actual dashboard.

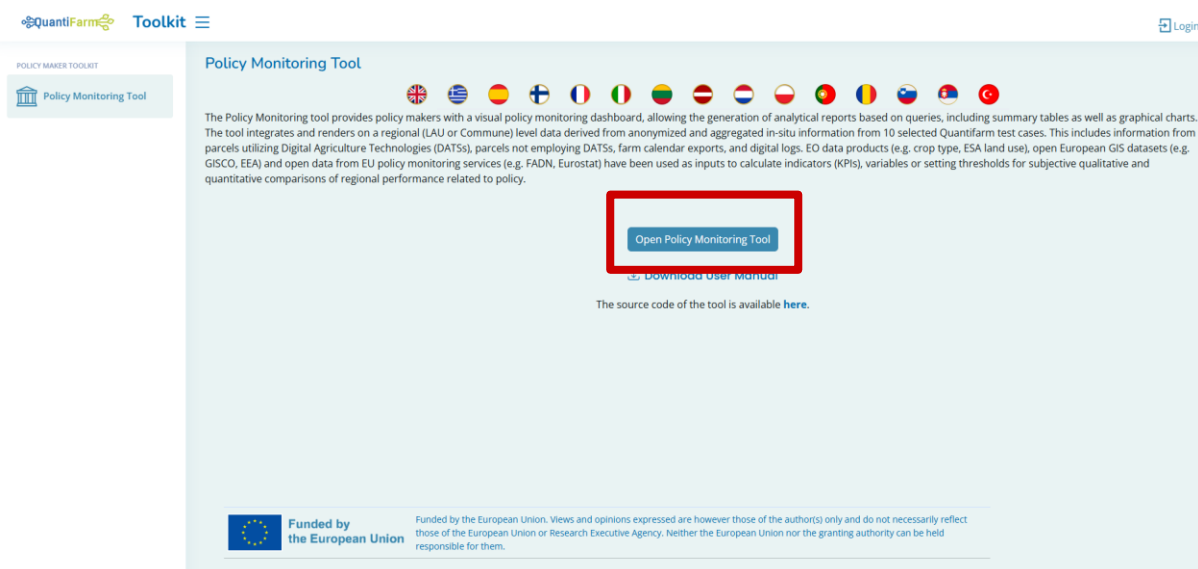


Figure 42. The updated «Policy Monitoring Tool» page



D3.7 QuantiFarm Toolkit – second version

In the Policy Monitoring Tool v2.0, the dashboard front page allows the user to filter selected content by selecting country, region, year, and crop type, along with a map viewer to meet user requirements. As mentioned in D3.4 “Tools for DATs Assessment and Policy Monitoring – second version” the updated list of countries for the 2023 growing season have been updated. The result is visible in the initial selection (Figure 43).

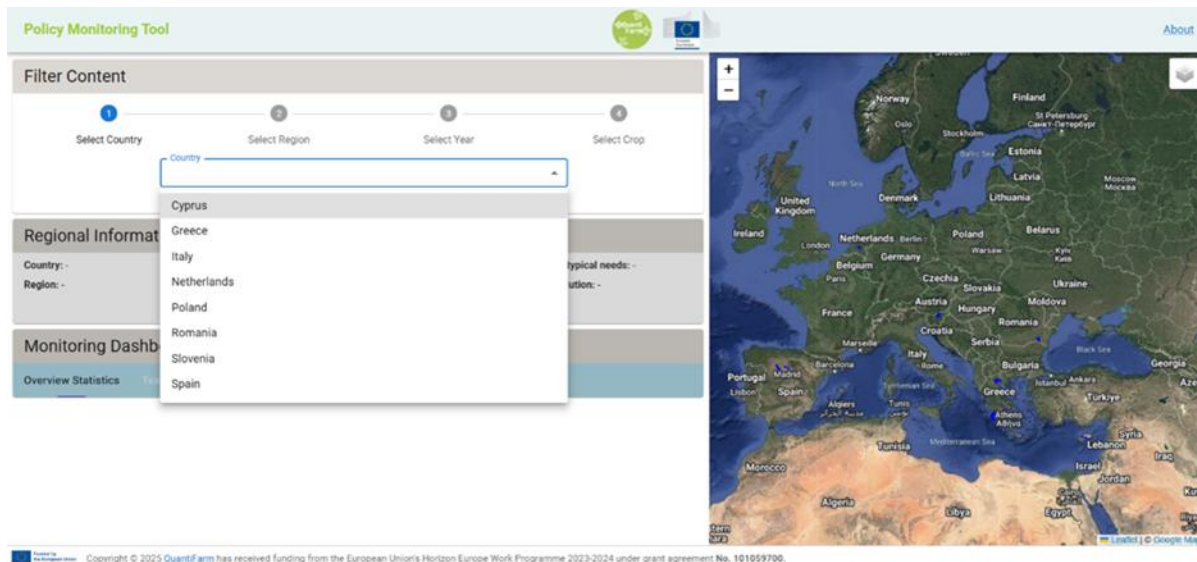


Figure 43. Main front page of the policy monitoring tool. The list of available countries is visible for the user to select

Details regarding the selected region are loaded along with various tabs that categorise agricultural statistics and indicators. For the execution of a Use case scenario example, we select

Greece>DIMOS OROPEIDIO LASITHIOU>2023>Potato.

The “finish” button confirms the selection and when pressed, it proceeds with the filtering selection and the zoom on the interactive map over the area of interest.

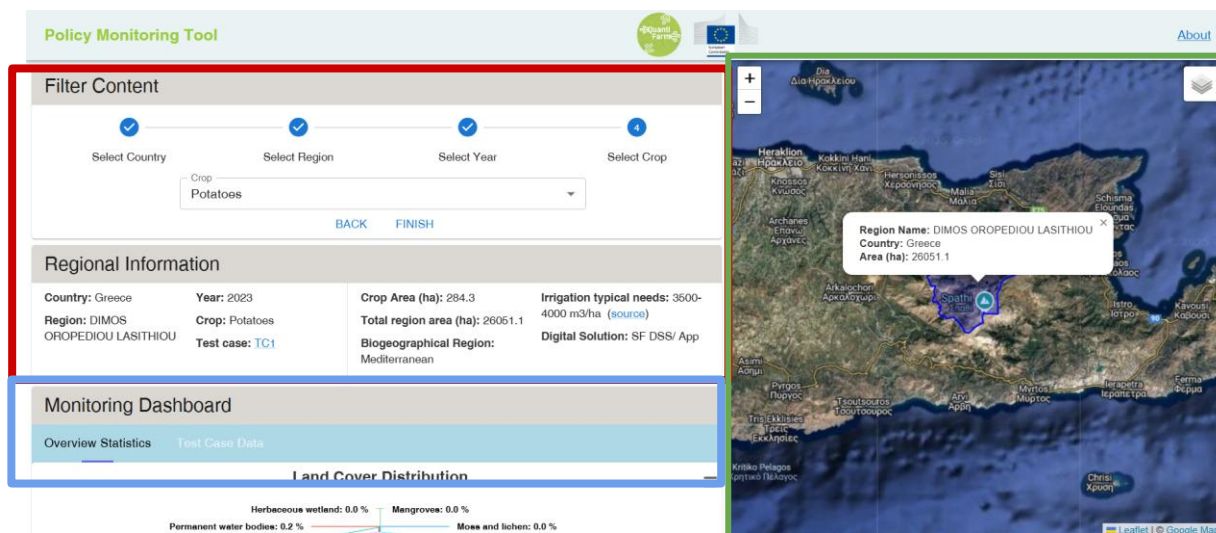


Figure 44. The Policy Monitoring Tool v2.0 dashboard front page after selection filtering criteria have been applied

The basic GUI elements of the dashboard front end consist of:

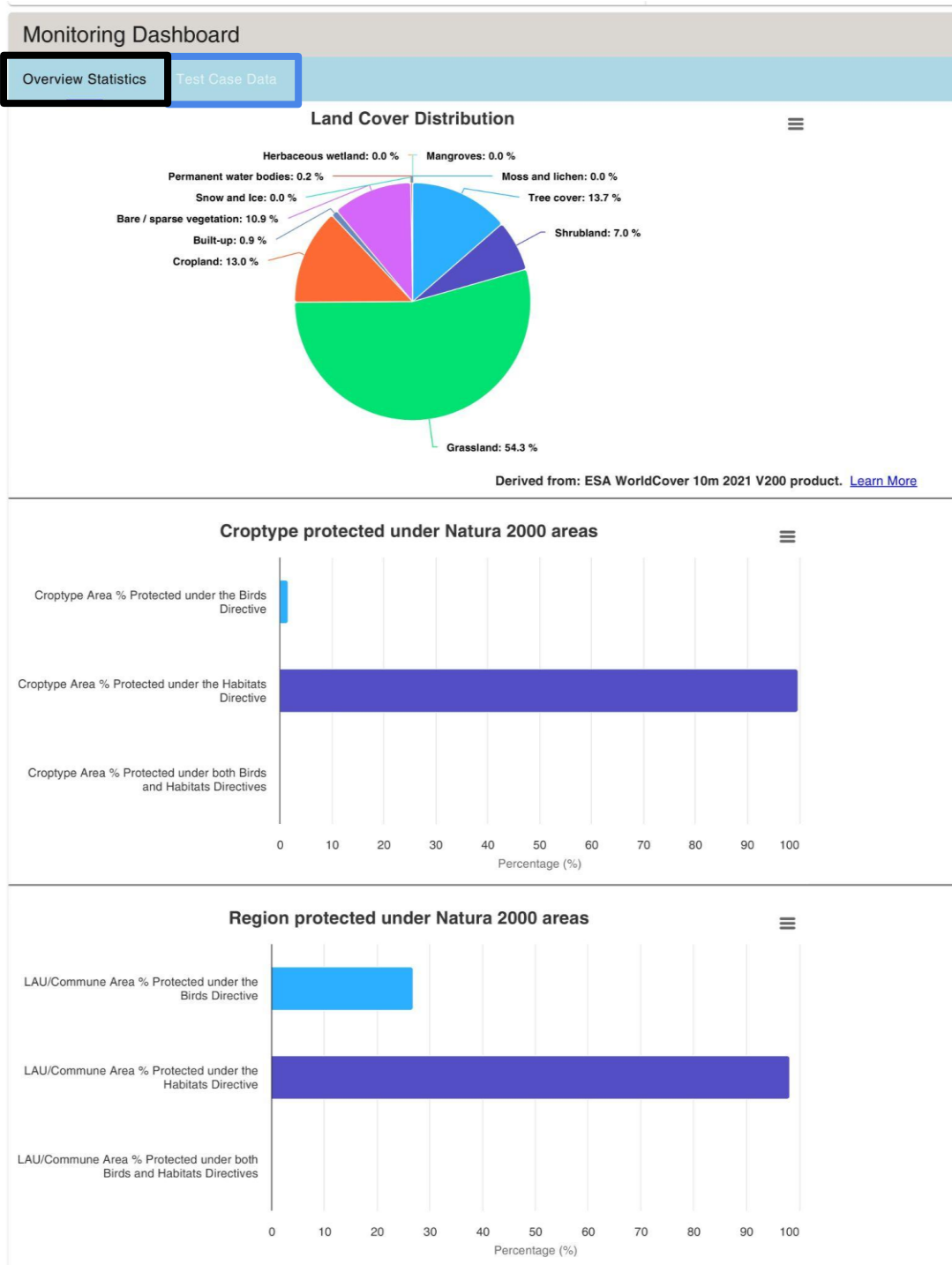
- A multi-step selection menu and the “regional information” where descriptive data regarding the selection are visible (Figure 44 red box)



D3.7 QuantiFarm Toolkit – second version

- An interactive map (Figure 44, green box)
- A “Monitoring dashboard” section including two tabs, providing relevant data and visuals (Figure 44, blue box). In this section the major changes and updates were introduced compared to the first version of the tool.

The “Overview statistics” tab (Figure 45, black box) displays a pie chart of land cover distribution, bars for protected areas under Natura 2000, and corresponding values and legends that the user can inspect by scrolling down. Compared to the first version, overview statistics of all regions included in the tool have been populated with data.



D3.7 QuantiFarm Toolkit – second version

Figure 45. The ‘Overview statistics’ tab contents include a pie chart regarding land use in the selected region and bars regarding the coverage of the region and the croptype

In the previous dashboard version, details regarding the selected region are loaded along with various tabs that categorise agricultural statistics and indicators. In the new version (v2), and for simplifying the browsing of the monitoring dashboard, related test case data have been merged in one tab called “Test Case Data” (Figure 45, blue box). This merge allows users an easier interaction, as currently more data categories are available from the first version, and populating a long list of tabs for every category was deemed impractical for navigation. The image below shows the list of 13 categories in their dashboard preview as a pop-up list (Figure 46).

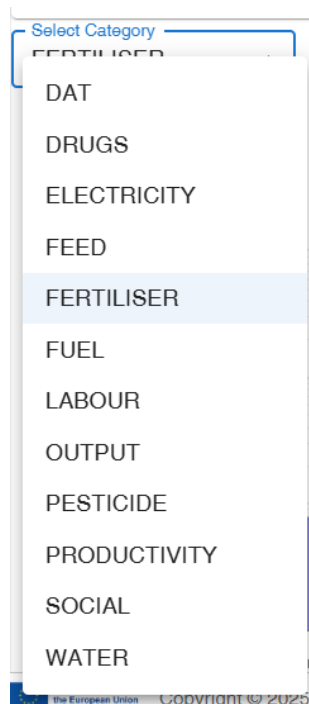


Figure 46. Overview of the 13 categories as a pop-up list available for the specified selection

The “Fertiliser” category (Figure 47, black box) features tables comparing agrochemicals used if all crop areas of the region are implementing the relevant DATS versus not implementing a DAT.

The regional average, maximum, and minimum usage of parcels are visible along with coloured “Regional difference” columns (Figure 47, orange box) that show the average benefit or deficit (depending on the sign character and colouring) for available pesticides and fertilisers indicators. Variable values are extrapolated to the entire regional area cultivated with the same crop type during the specific growing season. Therefore, the units in this column are not expressed per hectare, as they represent totals for the whole area.

An additional functionality implemented (Figure 47, red box) allows users to download the raw aggregated variables of the TC, enabling further examination or reuse of the data in an open format.



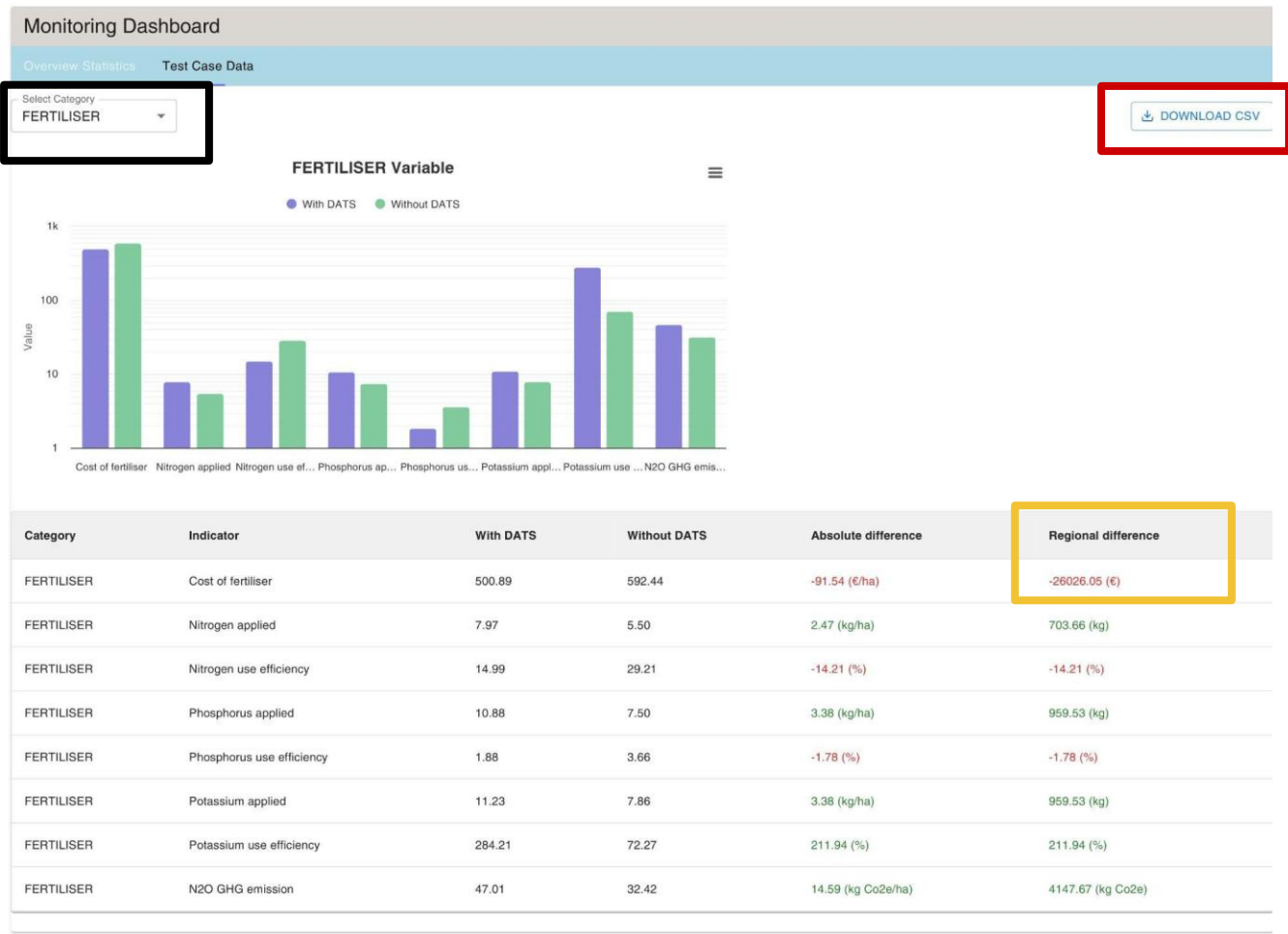


Figure 47. The “Fertilizers” category features tables that display relevant indicators along with their corresponding values, based on whether they are associated with DATS use or non-DATS use.

By clicking in the graph options a list of possible exports is visible for download (Figure 48).

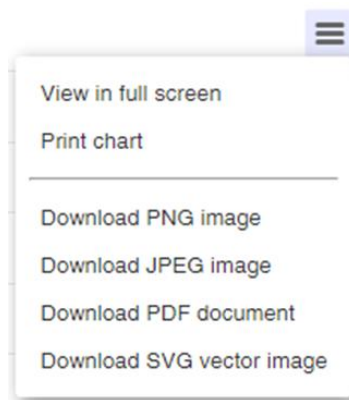


Figure 48. Available graph export options

3.5.3 Next steps

The policy monitoring tool will be upgraded with advanced data insights and a better user experience. Updates include data accuracy metrics, yearly trends visualization, GeoTIFF imagery for crop classifications via WMS/WFS, integration of national CAP plans and Green Deal goals, farm calendar/log uploads, and CAP indicators or FADN data where possible.



4. QuantiFarm FAQ

The Frequently Asked Questions (FAQ) section addresses the scope of the QuantiFarm toolkit, clarifying its purpose, detailing how digital solutions are presented, explaining the methods behind its recommendations and cost-benefit results and defining the QuantiFarm Test Cases. It emphasizes that while the toolkit offers guidance and real-world data from participating farms, it does not promote any solutions for commercial or marketing purposes. Users of the toolkit are reminded to consider their needs before making purchasing decisions. The FAQ outlines also how and when the toolkit's information is updated, reflecting both new research findings and any potential new submissions from technology providers.

Home Toolkit Test cases FAQ Contacts

Frequently Asked Questions (FAQ)

- 1. What is the purpose of this toolkit?**
The QuantiFarm toolkit aims to provide information on the properties and achieved performance of various types of digital solutions for the agriculture sector. It aims to empower farm advisors with additional knowledge and skills to effectively advise farmers regarding the selection, uptake, and application of DATS.
- 2. Are the digital solutions featured in the toolkit for marketing purposes?**
No, the information provided about digital solutions in this toolkit is not for commercial/marketing purposes. Our goal is to inform users and help them make well-informed decisions regarding the selection of digital solutions that correspond to their needs, priorities and characteristics.
- 3. How are recommendations and cost-benefit results produced?**
The recommendations and cost-benefit results presented in the toolkit are based on publicly available information from various sources including scientific articles, research findings, and company product data. They do not represent any personal assessments or results from actual pilot trials.
- 4. What are the QuantiFarm Test Cases?**
The toolkit features a range of 40 DATS, which were applied, tested and assessed within the QuantiFarm Test Cases. These solutions are linked to specific results derived from assessments conducted over three consecutive growing periods in particular crops and geographical conditions, thus providing increased validity. Assessments are based on data provided by participating farms. The DATS applied in QuantiFarm are indicated with the project's logo for easier identification.
- 5. Can I rely on the information in the toolkit for making purchasing decisions?**
While the toolkit serves as a helpful guide, it's important to conduct further research and consider your specific requirements before making any purchasing decisions. The toolkit is intended to complement your decision-making process, not to serve as the sole basis for it.
- 6. How often is the information in the toolkit updated?**
Updates will occur periodically as new data are integrated into the platform, expanding the DATS' inventory with new solutions. Additionally, results from ongoing and upcoming trials in the context of QuantiFarm Test Cases will be continuously incorporated, and new digital solutions are being added directly by technology providers. Users are encouraged to check back regularly for the latest information.

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Figure 49. FAQ section



5. Conclusions

This short report escorts the second integrated release of QuantiFarm toolkit which is available for use through a web-based dashboard <https://quantifarmtoolkit.eu/>

The next steps include extensive testing and utilisation of the QuantiFarm toolkit by a controlled set of users, collection of their feedback and refinement of the offered functionalities. The development of the QuantiFarm toolkit will be a continuous process and various improvements will be integrated when available. The next major release will be delivered in M45. The QuantiFarm Toolkit will be updated on a regular basis with data generated from the QuantiFarm assessment process.

